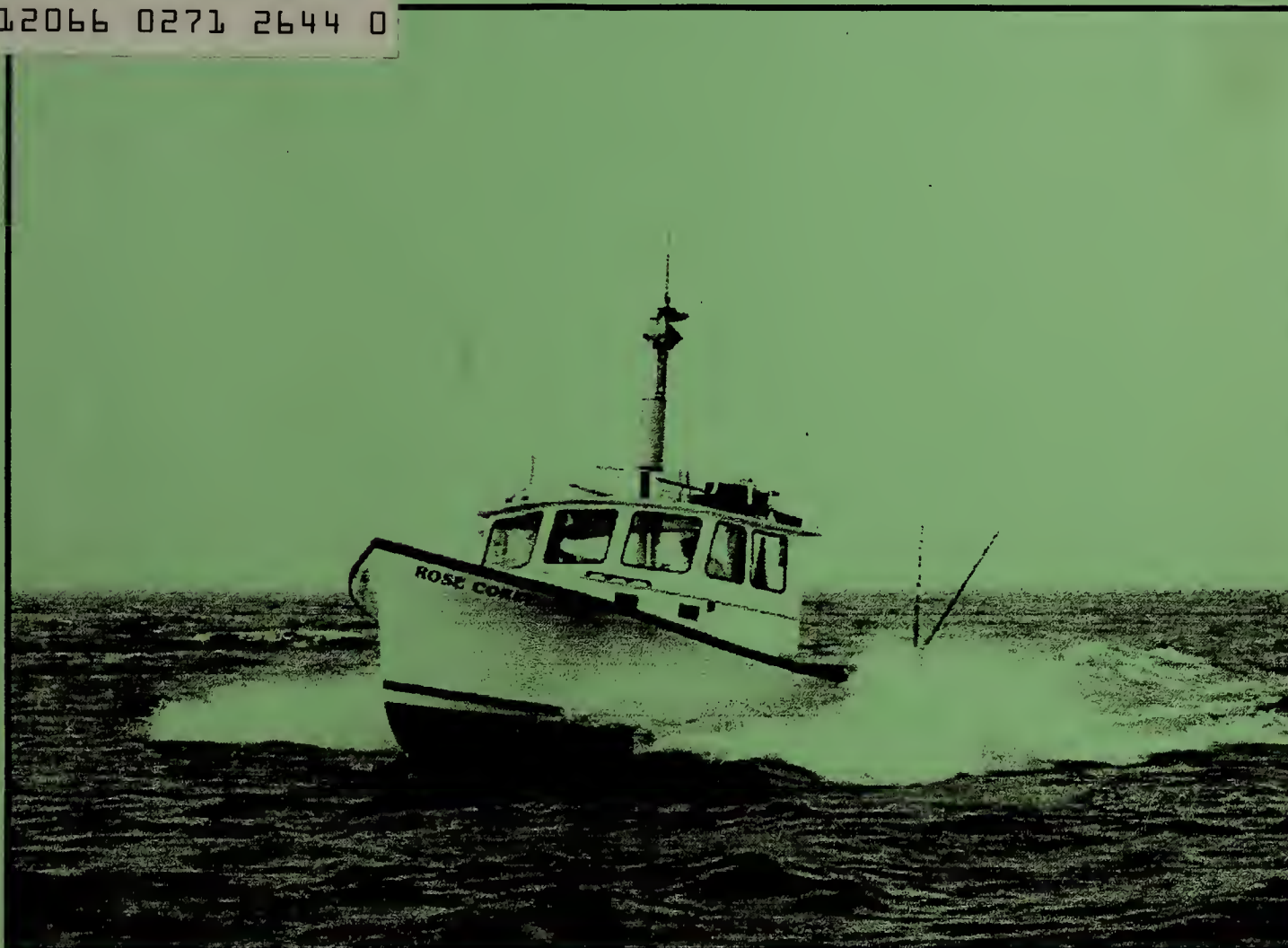
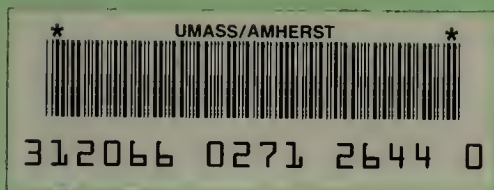


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NORTH COASTAL WATERSHED 1997/1998 WATER QUALITY ASSESSMENT REPORT



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NORTH COASTAL WATERSHED
1997/1998 WATER QUALITY ASSESSMENT REPORT

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Department of Environmental Protection
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DIVISION OF WATERSHED MANAGEMENT
WORCESTER, MASSACHUSETTS

May 2000

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LIST OF ACRONYMS

7Q10	Seven Day Ten Year Low Flow
ACEC	Areas of Critical Environmental Concern
BPJ	Best Professional Judgement
CFS	Cubic Feet per Second
CMR	Code of Massachusetts Regulations
CNOEC	Chronic No Observed Effect Concentration
CWA	Clean Water Act
DDT	Dichlordiphenyltrichloroethane
DEM	Department of Environmental Management
DFWELE	Department of Fisheries, Wildlife, and Environmental Law Enforcement
DMR	Discharge Monitoring Report
DO	Dissolved Oxygen
MA DPH	Massachusetts Department of Public Health
DWM	Department of Watershed Management
EPA	United States Environmental Protection Agency
GIS (MassGIS)	Geographic Information System
GP	Gravel Packed
GPM (D)	Gallons per Minute (Day)
JTU	Jackson Turbidity Unit
LC ₅₀	Lethal Concentration to 50% of the Test Organisms
MDC	Metropolitan District Commission
DEP	Massachusetts Department of Environmental Protection
MEPA	Massachusetts Environmental Policy Act Unit
MGD	Million Gallons per Day
mg/L	Milligram per Liter
NCCW	Non-Contact Cooling Water
NH ₃ -N	Ammonia-Nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	Non Point Source
NTU	Nephelometric Turbidity Units
ORW	Outstanding Resource Waters
PAH	Polyaromatic Hydrocarbons
PALIS	Pond and Lake Information System
PCB	Polychlorinated Biphenols
PPM	Parts Per Million
PWS	Public Water Supply
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/ Quality Control
RBP	Rapid Bioassessment Protocol
SARIS	Stream and River Inventory System
SS	Suspended Solids
SU	Standard Units
SWQS	Massachusetts Surface Water Quality Standards
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TRC	Total Residual Chlorine
USFDA	United States Food and Drug Administration
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WMA	Water Management Act
WWTP	Waste Water Treatment Plant

EXECUTIVE SUMMARY
NORTH COASTAL WATERSHED 1997/1998 WATER QUALITY
ASSESSMENT REPORT

The assessment of current water quality conditions is a key step in the successful implementation of the Watershed Approach. This critical phase provides basic information needed to focus resource protection and remediation activities later in the watershed management planning process. Detailed information regarding individual river segments, estuaries, coastal embayments, marine waters and lakes in the North Coastal Watershed is presented in this assessment report. The Massachusetts Surface Water Quality Standards designate the most sensitive uses (Aquatic Life, Fish Consumption, Primary and Secondary Contact Recreation, Shellfishing and Aesthetics) for which surface waters shall be protected. The following is a brief summary of water quality conditions in the North Coastal Watershed in relation to their support of those designated uses.

RIVERS, ESTUARIES, COASTAL EMBAYMENTS, AND MARINE WATERS

A total of 37.3 river miles and 34.12 square miles of coastal/marine waters in the North Coastal Watershed are evaluated in this report. The status of each designated use is summarized below.

Aquatic Life Use

The *Aquatic Life Use* is supported when suitable habitat (including water quality) is available for sustaining a native, naturally diverse, community of aquatic flora and fauna. Impairment of the *Aquatic Life Use* (non-support or partial support) may result from anthropogenic stressors that include point and/or nonpoint source(s) of pollution and hydrologic modification. The status of the *Aquatic Life Use* in the North Coastal Watershed is as follows:

Aquatic Life Use Summary - Inland

- 1.9 river miles support
- 19.5 river miles partial support
- 3.9 river miles non-support
- 12.0 river miles not assessed

Aquatic Life Use Summary - Coastal and Marine

- 10.74 square miles support
- 0.8 square miles non-support
- 22.58 square miles not assessed

The *Aquatic Life Use* is supported for the entire length/area of six waterbodies in the North Coastal Watershed: Frost Fish Brook, Porter River, Waters River, Danvers River, Forest River, and Salem Sound. Additionally portions of the Bass and Crane rivers also support this use.

Multiple waterbodies in the North Coastal Watershed are not assessed for the *Aquatic Life Use* at this time including:

- Essex Bay System (Essex River and Essex Bay),
- Annisquam River System (Alewife Brook, Mill and Annisquam rivers, as well as Rockport and Gloucester harbors),
- Manchester Harbor,
- Bass River System (portions of the Bass River)
- Crane River System (portions of the Crane River),
- North River System (portions of Proctor Brook and the North River),
- Beverly Harbor,
- Salem Harbor,
- Marblehead Harbor,
- Nahant Bay,
- Saugus River System (portions of the Saugus River, Hawkes Brook, Pines River and Lynn Harbor).

The *Aquatic Life Use* is partially supported in three small streams (Cat Brook in the Manchester Harbor System, and Beaver and Crane brooks in the Crane River System) due low levels of dissolved oxygen (DO). The low pH in Cat Brook also impaired this use. Whether or not these conditions are naturally occurring merits further investigation.

The *Aquatic Life Use* in the North River System is not supported in portions of two brooks (Goldthwait and Proctor). In the upper portion of Goldthwait Brook, hydromodification and habitat degradation impair (partial support) this use. The combined effects of the Water Management Act (WMA) withdrawals (Eastman Gelatine Company, Peabody Water Department, Salem Country Club, Kearwood Country Club) likely diminish instream flow thereby impacting aquatic communities. Downstream from the Eastman Gelatine Company's discharge, this use is not supported due to severe instream toxicity during stormwater events. The *Aquatic Life Use* in Proctor Brook is also assessed as non-support downstream from its confluence with Goldthwait Brook based on habitat quality limitations, nutrient enrichment, and a severely impaired benthic community.

Where assessed, the *Aquatic Life Use* in the Saugus River System is either partial or non-support. In the freshwaters of the Saugus River System, low DO, slightly elevated nutrients, and low flow (habitat limitations) were documented. The Saugus River and Beaverdam Brook are impaired by streamflow and/or habitat limitations that are likely related, in part, to water withdrawals. The Saugus River estuary is heavily influenced by several National Pollution Discharge Elimination System (NPDES) discharges: General Electric Lynn Company (GE Lynn), Refuse Energy Systems Company (RESCO) and the Lynn Water and Sewer Commission. While the cumulative impacts of the GE Lynn and RESCO facility salt water intakes and thermal discharges on the biota of the Saugus River estuary are unknown, the *Aquatic Life Use* is evaluated as non-support for the following reasons:

- the facilities are located on opposite shores of the estuary,
- impingement reduction mechanisms for at least one of the GE salt water intakes did not return the organisms to the river,
- the potential for thermal barriers to passage/migration resulting from the cumulative effects of intakes and thermal discharges, and
- biocide residuals in the discharges (concentrations unknown).

The impacts of water withdrawals and wastewater discharges (both municipal and industrial) as well as stormwater runoff to aquatic life in the North Coastal Watershed need further investigation. Investigations into the impacts of water withdrawals on streamflow should be conducted prior to WMA permit review and/or reissuance. For facilities which generate power via once-through cooling water systems, a comprehensive review of the present NPDES permit requirements should be performed to identify areas within the permits that may need modification, and/or specific issues that are not currently being addressed. In the North Coastal Watershed these facilities include the Eastman Gelatine Corporation, GE Company in Lynn, RESCOE, and USGenNE (formerly New England Power Salem Station). Since the quality of some aquatic resources (fish, shellfish, etc.) within receiving waters is declining rapidly, the impact of once-through cooling needs to be re-examined during the next NPDES permit review/reissuance. Analysis of the information gathered should include, at a minimum, review by the Environmental Protection Agency, Department of Environmental Protection, Division of Marine Fisheries, National Oceanographic and Atmospheric Administration and Coastal Zone Management. Local watershed groups, because of their intimate relationship with the receiving waters in question, should actively participate in the public review process.

Fish Consumption Use

The *Fish Consumption Use* is supported when there are no pollutants present that result in unacceptable concentrations in edible portions of marketable fish or shellfish or for the recreational use of fish, shellfish, other aquatic life or wildlife for human consumption. This use is assessed using the Department of Public Health's (MA DPH) Fish Consumption Advisory List. It should be noted, however, that in September 1994, the MA DPH issued a statewide Interim Freshwater Fish Advisory because of risks associated with elevated levels of mercury in certain species of freshwater fish. The interim advisory recommends that "Pregnant women should be advised of the possible health risk from eating fish taken from Massachusetts freshwaterbodies in order to prevent exposure of developing fetuses to mercury." The interim advisory does not include stocked trout or farm-raised fish sold commercially. Because of the interim advisory, however, the assessment of the *Fish Consumption Use* is limited to those waterbodies specifically listed on the MA DPH Fish Consumption Advisory List where the use is non-support. The status of the *Fish Consumption Use* in the North Coastal Watershed is as follows:

Fish Consumption Use Summary - Inland

- 37.3 river miles not assessed

Fish Consumption Summary - Coastal and Marine

- 34.12 square miles not assessed

With the exception of Chebacco Lake (see Lakes/Ponds) there are no site-specific MA DPH fish consumption advisories in place in the North Coastal Watershed.

Recreational Uses

The *Primary Contact Recreational Use* is supported when conditions are suitable for any recreation or other water activity during which there is prolonged and intimate contact with the water with a significant risk of ingestion. Activities include, but are not limited to, wading, swimming, diving, surfing and water skiing. The status of the *Primary Contact Recreational Use* in the North Coastal Watershed is as follows:

Primary Contact Use Summary - Inland

- 3.8 river miles support
- 20.9 river miles non-support
- 12.6 river miles not assessed

Primary Contact Use Summary - Coastal and Marine

- 0.05 square miles partial support
- 12.92 square miles non-support
- 21.15 square miles not assessed

While 34% of the river miles and 62% of the coastal areas are not assessed for the *Primary Contact Recreational Use*, portions of only two rivers in the North Coastal Watershed were fully supported for this use. These two rivers are:

- the lower 0.3 miles of the Bass River between the outlet of upper Shoe Pond to the outlet of lower Shoe Pond, and
- the upper 3.5 miles of the Saugus River between the Lynn Water & Sewer Commission diversion canal and the confluence with Hawkes Brook (DEP/DWM data summary, Figure 1).

Multiple Combined Sewer Overflows (CSOs) have recently been removed from the North Coastal Watershed and water quality conditions are improving. However, CSOs and failing septic systems still impair the *Primary Contact Recreational Use* in Gloucester, Beverly and Lynn harbors, Nahant Bay, and the Saugus River. Two additional streams (Danvers River and Hawkes Brook) are suspected to receive flow from CSOs.

Fecal coliform bacteria levels were extremely elevated in the Saugus River Subwatershed. Current remediation activities such as the Lynn Water and Sewer Commission CSO Consolidation Conduit and Storage/Treatment – Stacey Brook State Revolving Fund (SRF) project continue to reduce bacteria levels. Post implementation monitoring of such projects is recommended to document whether or not water quality improvements are being realized. Organizations such as Salem Sound 2000 and the Saugus River Watershed Council have been instrumental in the identification of areas of concern.

Additionally, failing septic systems are known contributors of fecal coliform bacteria in the North Coastal Watershed. The City of Gloucester is currently conducting town-wide Title V repairs and the Department of Public works has been correcting sewage problems in the City of Salem since 1994 (Appendix D). Upon completion of these updates/upgrades additional fecal coliform bacteria sampling during wet and dry weather conditions is recommended.

The *Secondary Contact Recreational Use* is supported when conditions are suitable for any recreation or other water use during which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities. The status of the *Secondary Contact Recreational Use* in the North Coastal Watershed is as follows:

Secondary Contact Use Summary - Inland

- 14.3 river miles support
- 9.1 river miles partial support
- 4.6 river miles non-support
- 9.3 river miles not assessed

Secondary Contact Use Summary - Coastal and Marine

- 11.99 square miles support
- 0.98 square miles non-support
- 21.15 square miles not assessed

Thirty-eight percent of the river miles and 35% of the coastal areas assessed in the North Coastal Watershed fully support the *Secondary Contact Recreational Use*. In addition to those areas that supported the *Primary Contact Recreational Use*, the *Secondary Contact Recreational Use* is supported in four streams and two coastal waterbodies:

- Beaver Brook and the majority of Crane Brook in the Crane River System,
- Beaverdam and Hawkes brooks in the Saugus River System,
- Nahant Bay, and
- Lynn Harbor.

In addition to elevated fecal coliform bacteria levels related to CSOs and failing septic systems, causes of impairment to the *Secondary Contact Recreational Use* include oil sheens, turbidity, and algae (mats blooms and filaments).

Aesthetics Use

The *Aesthetics Use* is supported when surface waters are free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life. The status of the *Aesthetics Use* in the North Coastal Watershed is as follows:

Aesthetics Use Summary - Inland

- 10.3 river miles support
- 7.8 river miles partial support
- 4.8 river miles non-support
- 14.4 river miles not assessed

Aesthetics Use Summary - Coastal and Marine

- 10.01 square miles support
- 0.9 square miles non-support
- 23.21 square miles not assessed

The *Aesthetics Use* is supported in four freshwater streams including Frost Fish Brook in the Bass River System, portions of Crane Brook in the Crane River System, as well as Beaverdam Brook and the Saugus River (from the diversion canal to the Saugus Iron Works) in the Saugus River System. The only coastal water assessed as supporting this use is Salem Sound.

The *Aesthetics Use* is impaired in a total of four freshwater streams and three coastal areas including:

- a portion of Crane Brook and the Crane River in the Crane River System,
- a portion of Proctor Brook in the North River System,
- the Saugus River from the outlet of Lake Quannapowitt to the diversion canal in the Saugus River System,
- a portion of the upper Porter River (from the Route 62 bridge to the Route 128 bridge) in the Bass River System,
- the Waters River in the Crane River System, and
- the Saugus River estuary (from the Iron Works to the Lynn Harbor) in the Saugus River System.

Common causes of impairment to the *Aesthetics Use* include sedimentation, turbidity/grey water, trash and debris and algal blooms (DEP/DWM data summary, Figure 1). Surface oil sheens related to the GE Lynn stormwater outfalls impair the *Aesthetics Use* in the Saugus River estuary.

Shellfishing Use

The *Shellfishing Use* is supported when shellfish harvested from approved Open Shellfish Areas (Class SA) are suitable for consumption without depuration and shellfish harvested from approved Restricted Shellfish Areas (Class SB) are suitable for consumption with depuration. The Division of Marine Fisheries (DMF) classifies shellfishing areas in the North Coastal Watershed. The *Shellfishing Use* for this report was assessed using the DMF shellfishing closure listing dated 1 January 1999. The status of the 132,742.1 acres of shellfishing beds in the entire North Coastal Watershed (including areas that extend into open-water not specifically included in this assessment report) is as follows:

DMF Classification Type	DEP Use Support Status	DMF Area (acres)	% of total acreage
Approved	Support	18777.44	14%
Conditionally Approved	Partial Support	2575.16	2%
Management Closure	Not assessed	45720.53	34%
Prohibited	Non-support	65668.92	49%

Individual DMF management area classifications are provided in Appendix F of this report. It should be noted that their areas are defined in acres of shellfishing habitat.

LAKES/PONDS

Overall use support status and trophic status of the lakes surveyed in the North Coastal Watershed are presented in Tables 1 and 2, respectively. It should be noted that lakes, or portions of lakes, are listed as undetermined when indicators were not readily observable. With this approach, the assessment of lakes in the North Coastal Watershed is limited to a "best case" picture (i.e., only the most obvious impairments are reported). Potentially more of the lake acreage would be listed as impaired or in a more enriched trophic status if more variables were measured and more criteria assessed.

Table 1. North Coastal Watershed Lakes Use Support Summary Summer, 1997. (In Acres)

USE/DEGREE SUPPORTED	SUPPORT (THREATENED)	PARTIAL SUPPORT	NON- SUPPORT	NOT ASSESSED
Aquatic Life	0	545	5	1550
Fish Consumption*	0	0	204	1896
Swimmable	0	593	249	1258
Secondary Contact	1252	593	249	6
Aesthetics	1252	593	249	6

* Fish Consumption results do not include the statewide consumption advisory (i.e., they are site-specific advisories as reported by the Department of Public Health (1998).

N.B. - These results represent the most recent assessments of lakes/ponds in the North Coastal Watershed. These data also represent about 48% (43 of 89) of the lakes/ponds in the North Coastal Watershed and about 87% (2,100 of 2,415) of the acreage.

Table 2. North Coastal Watershed Lakes Trophic Status Summary Summer, 1997.

TROPHIC STATUS	NUMBER OF LAKES	ACRES
Oligotrophic	0	0
Mesotrophic	4	177
Eutrophic	17	930
Hypereutrophic	4	44
Dystrophic	0	0
Undetermined/ Not Attainable	18	949
Total	43	2100

N.B. - These results represent the most recent assessments of lakes/ponds in the North Coastal Watershed. These data also represent about 48% (43 of 89) of the lakes/ponds in the North Coastal Watershed and about 87% (2,100 of 2,415) of the acreage.

Despite the "best case" scenario that is favored by the North Coastal Watershed lake assessment approach, 49% (representing 46% of the surveyed area) of the lakes showed severe (eutrophic or hypereutrophic) symptoms of succession. Presumably, additional testing of dissolved oxygen, chlorophyll, and/or nutrients would corroborate that trophic status conditions are this advanced.

Four non-native aquatic plant species were found infrequently in the lakes of the North Coastal Watershed. Neither South American waterweed nor water hyacinth are likely to be immediate threats to spread from their current locations. The estuarine environment and northern climate should keep them in check. Fanwort (*Cabomba caroliniana*) and curly leaf pondweed (*Potamogeton crispus*), however, are particularly invasive species that can spread vegetatively via cuttings that may float downstream or be transported mechanically between lakes.

The most frequently occurring non-native wetland species was purple loosestrife (*Lythrum salicaria*). Populations of this plant are pervasive throughout the entire watershed. Its presence was recorded at over three-quarters (77%) of the lakes. The other non-native wetland plant observed in the watershed is the reed grass (*Phragmites australis*). The two non-native wetland species were co-located at three lakes (Cape Pond, Rockport, Floating Bridge Pond, Lynn, and Niles Pond, Gloucester).

Based on the data collected by DEP DWM's fish contaminant survey, the MA DPH issued a fish consumption advisory for Chebacco Lake in Essex/Hamilton. Therefore the *Fish Consumption Use* is not supported for the entire 204 acres of this lake.

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NORTH COASTAL WATERSHED 1997/1998 DEP DWM Water Quality, Macroinvertebrate and Fish Consumption Station Data Summary

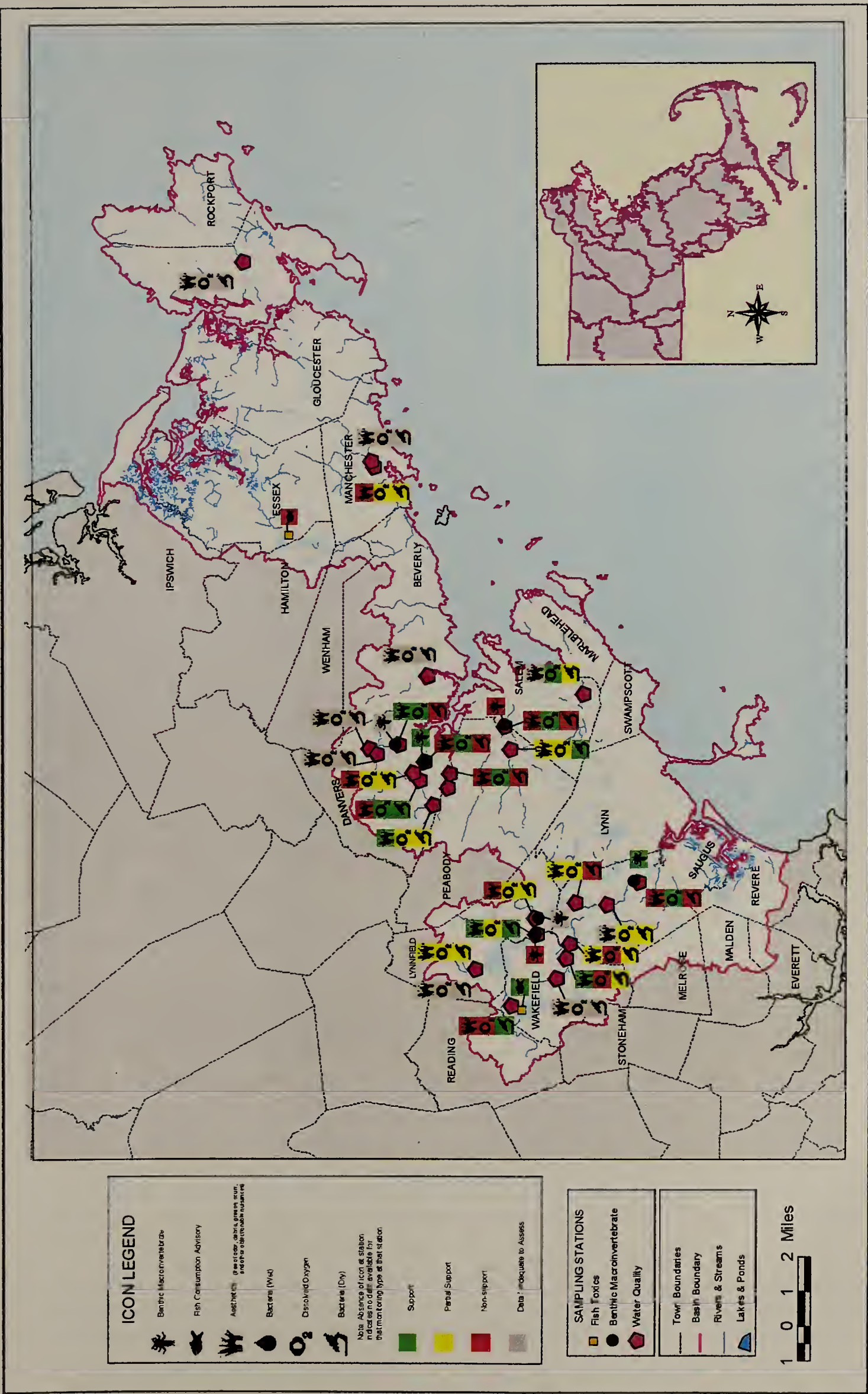


Figure 1. 1997/1998 DEP DWM water quality, macroinvertebrate and fish consumption station data summary in the North Coastal Watershed

INTRODUCTION

The Massachusetts Watershed Initiative is a collaborative effort between state and federal environmental agencies, municipal agencies, citizens, non-profit groups, businesses and industries in the watershed.

The mission is to improve water quality conditions and to provide a framework under which the restoration and/or protection of the watershed's natural resources can be achieved.

Implementation of this project is underway in a process known as the "Watershed Approach". The five-year cycle of the Watershed Approach, as illustrated in Figure 2, provides the management structure to carry out the mission. This report presents the assessment of water quality conditions in the North Coastal Watershed. The assessment is based on information that has been researched and developed through the first three years (information gathering, monitoring, and assessment) of the five year cycle by the Department of Environmental Protection (DEP) as part of its federal mandate under the Federal Water Pollution Control Act (commonly known as the Clean Water Act).

THE CLEAN WATER ACT: IMPLEMENTATION THROUGH THE FIVE-YEAR CYCLE OF THE WATERSHED APPROACH

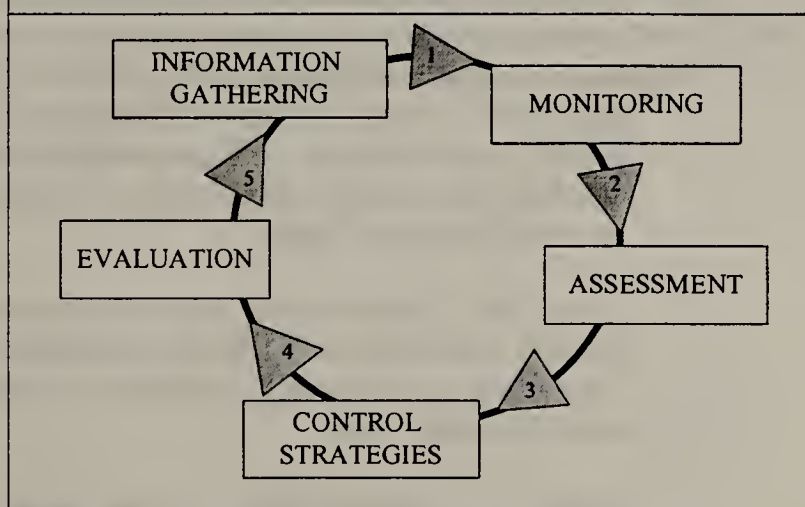


Figure 2. Clean Water Act Implementation Cycle

The objective of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Environmental Law Reporter 1988). To meet this goal, the CWA requires states to develop information on the quality of the Nation's water resources and report this information to the U.S. Environmental Protection Agency (EPA), the U.S. Congress, and the public. Together, these agencies are responsible for implementation of the CWA mandates. Under Section 305(b) of the Federal Clean Water Act, DEP must submit a statewide report every two years to the EPA, which describes the status of water quality in the Commonwealth. The most recent 305(b) report is the *Commonwealth of Massachusetts Summary of Water Quality 1998* (DEP 1998b). The 305(b) statewide report is based on the compilation of information for the Commonwealth's 27 watersheds. The 305(b) report compiles data from a variety of sources, and provides an evaluation of water quality, progress made towards maintaining and restoring water quality, and the extent to which problems remain at the statewide level. At the watershed level, instream biological, habitat, physical/chemical, toxicity data and other information is evaluated to assess the status of water quality conditions. This analysis follows a standardized process described below (Assessment Methodology).

ASSESSMENT METHODOLOGY

WATER QUALITY CLASSIFICATION

The Massachusetts Surface Water Quality Standards (SWQS) designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected; prescribe minimum water quality criteria required to sustain the designated uses; and include provisions for the prohibition of discharges (DEP 1996). These regulations undergo public review every three years. These surface waters are segmented and each segment is assigned to one of the six classes described below:

Inland Water Classes

1. *Class A – These waters are designated as a source of public water supply. To the extent compatible with this use they shall be an excellent habitat for fish, other aquatic life and wildlife, and suitable for primary and secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters (DEP 1995) under 314 CMR 4.04(3).*
2. *Class B – These waters are designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation. Where designated they shall be suitable as a source of water supply with appropriate treatment (Treated Water Supply). They shall be suitable for*

irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.

3. *Class C – These waters are designated as a habitat for fish, other aquatic life and wildlife, and for secondary contact recreation. These waters shall be suitable for the irrigation of crops used for consumption after cooking and for compatible industrial cooling and process uses. These waters shall have good aesthetic value.*

Coastal and Marine Classes

4. *Class SA – These waters are designated as an excellent habitat for fish, other aquatic life and wildlife and for primary and secondary recreation. In approved areas they shall be suitable for shellfish harvesting without depuration (Open Shellfishing Areas). These waters shall have excellent aesthetic value.*
5. *Class SB – These waters are designated as a habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. In approved areas they shall be suitable for shellfish harvesting with depuration (Restricted Shellfishing Areas). These waters shall have consistently good aesthetic value.*
6. *Class SC – These waters are designated as a habitat for fish, other aquatic life, and wildlife and for secondary contact recreation. They shall also be suitable for certain industrial cooling and process uses. These waters shall have good aesthetic value.*

The CWA Section 305(b) water quality reporting process is an essential aspect of the Nation's water pollution control effort. It is the principal means by which EPA, Congress, and the public evaluate existing water quality, assess progress made in maintaining and restoring water quality, and determine the extent of remaining problems. In so doing, the States report on waterbodies within the context of meeting their designated uses (described above in each class). Each class is identified by the most sensitive, and therefore governing, water uses to be achieved and protected. These uses include: Aquatic Life, Fish Consumption, Drinking Water, Primary and Secondary Contact Recreation, Shellfishing and Aesthetics. Three subclasses of Aquatic Life are also designated in the standards: Cold Water Fishery (capable of sustaining a year-round population of cold water aquatic life such as trout), Warm Water Fishery (waters which are not capable of sustaining a year-round population of cold water aquatic life), and Marine Fishery (suitable for sustaining marine flora and fauna).

A summary of the state water quality standards (Table 3) prescribes minimum water quality criteria to sustain the designated uses. Furthermore these standards describe the hydrological conditions at which water quality criteria must be met (DEP 1996). In rivers and streams, the lowest flow conditions at and above which criteria must be met is the lowest mean flow for seven consecutive days to be expected once in ten years (7Q10). In artificially regulated waters, the lowest flow conditions at which criteria must be met is the flow equal or exceeded 99% of the time on a yearly basis or another equivalent flow which has been agreed upon. In coastal and marine waters and for lakes and ponds the most severe hydrological condition is determined by DEP on a case by case basis.

The availability of appropriate and reliable scientific data and technical information is fundamental to the 305(b) reporting process. It is EPA policy (EPA Order 5360.1 CHG 1) that any organization performing work for or on behalf of EPA establish a Quality System to support the development, review, approval, implementation, and assessment of data collection operations. To this end, DEP describes its Quality System in an EPA-approved Quality Management Plan (QMP) to ensure that environmental data collected or compiled by the agency are of known and documented quality and are suitable for their intended use. For external sources of information, DEP requires all of the following: 1) an appropriate *Quality Assurance Project Plan* including a QA/QC plan, 2) use of a state certified lab (certified in the applicable analysis), 3) data management QA/QC be described, and 4) the information be documented in a citable report.

EPA provides guidelines to the States for making their use support determinations (EPA 1997). The determination of whether or not a waterbody supports each of its designated uses is a function of the type(s), quality and quantity of available current information. Each designated use within a given segment is individually assessed as 1) **support**, 2) **partial support**, or 3) **non-support**. The term **threatened** is used

when the use is fully supported but may not support the use within two years because of adverse pollution trends or anticipated sources of pollution. When too little current data/information exists or no reliable data are available the use is **not assessed**. Although data/information older than five years are usually considered "historical" and used for descriptive purposes, they can be utilized in the use support determination providing they are known to reflect the current conditions. While the water quality standards (Table 3) prescribe minimum water quality criteria to sustain the designated uses, numerical criteria are not available for every indicator of pollution. Best available guidance in the literature may be applied in lieu of actual numerical criteria (e.g., freshwater sediment data may be compared to *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* 1993 by D. Persaud, R. Jaagumagi and A. Hayton).

Table 3. Summary of Massachusetts Surface Water Quality Standards (DEP 1996). *Note: Italics are direct quotations.*

Dissolved Oxygen	<u>Class A, BCWF*, SA:</u> ≥ 6.0 mg/L and $\geq 75\%$ saturation unless background conditions are lower <u>Class BWWF**, SB:</u> ≥ 5.0 mg/L and $\geq 60\%$ saturation unless background conditions are lower <u>Class C:</u> Not ≤ 5.0 mg/L for more than 16 of any 24 –hour period and not ≤ 3.0 mg/L anytime unless background conditions are lower; levels cannot be lowered below 50% saturation due to a discharge <u>Class SC:</u> Not ≤ 5.0 mg/L for more than 16 of any 24 –hour period and not ≤ 4.0 mg/L anytime unless background conditions are lower; and 50% saturation; levels cannot be lowered below 50% saturation due to a discharge
Temperature	<u>Class A:</u> $\leq 68^{\circ}\text{F}$ (20°C) and $\Delta 1.5^{\circ}\text{F}$ (0.8°C) for Cold Water and $\leq 83^{\circ}\text{F}$ (28.3°C) and $\Delta 1.5^{\circ}\text{F}$ (0.8°C) for Warm Water <u>Class BCWF:</u> $\leq 68^{\circ}\text{F}$ (20°C) and $\Delta 3^{\circ}\text{F}$ (1.7°C) due to a discharge <u>Class BWWF:</u> $\leq 83^{\circ}\text{F}$ (28.3°C) and $\Delta 3^{\circ}\text{F}$ (1.7°C) in lakes, $\Delta 5^{\circ}\text{F}$ (2.8°C) in rivers <u>Class C, SC:</u> $\leq 85^{\circ}\text{F}$ (29.4°C) nor $\Delta 5^{\circ}\text{F}$ (2.8°C) due to a discharge <u>Class SA:</u> $\leq 85^{\circ}\text{F}$ (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and $\Delta 1.5^{\circ}\text{F}$ (0.8°C) <u>Class SB:</u> $\leq 85^{\circ}\text{F}$ (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and $\Delta 1.5^{\circ}\text{F}$ (0.8°C) between July through September and $\Delta 4.0^{\circ}\text{F}$ (2.2°C) between October through June
pH	<u>Class A, BCWF, BWWF:</u> 6.5 – 8.3 and $\Delta 0.5$ outside the background range. <u>Class C:</u> 6.5 – 9.0 and $\Delta 1.0$ outside the naturally occurring range. <u>Class SA, SB:</u> 6.5 – 8.5 and $\Delta 0.2$ outside the normally occurring range. <u>Class SC:</u> 6.5 – 9.0 and $\Delta 0.5$ outside the naturally occurring range.
Fecal Coliform Bacteria	<u>Class A:</u> an arithmetic mean of < 20 organisms /100 ml in any representative set of samples and $< 10\%$ of the samples > 100 organisms/100 ml. <u>Class B:</u> a geometric mean of < 200 organisms /100 ml in any representative set of samples and $< 10\%$ of the samples > 400 organisms /100 ml. (This criterion can be applied on a seasonal basis at the discretion of the DEP.) <u>Class C:</u> a geometric mean of < 1000 organisms /100ml, and $< 10\%$ of the samples > 2000 organisms/100 ml. <u>Class SA:</u> approved Open Shellfish Areas: a geometric mean (MPN method) of < 14 organisms/100 ml and $< 10\%$ of the samples > 43 organisms/100 ml (MPN method). Waters not designated for shellfishing: $< a$ geometric mean of 200 organisms in any representative set of samples, and $< 10\%$ of the samples > 400 organisms /100 ml. (This criterion can be applied on a seasonal basis at the discretion of the DEP.) <u>Class SB:</u> approved Restricted Shellfish Areas: $< a$ fecal coliform median or geometric mean (MPN method) of 88 organisms/100 ml and $< 10\%$ of the samples > 260 organisms /100 ml (MPN method). Waters not designated for shellfishing: $< a$ geometric mean of 200 organisms in any representative set of samples, and $< 10\%$ of the samples > 400 organisms /100 ml. (This criterion can be applied on a seasonal basis at the discretion of the DEP.) <u>Class SC:</u> $< a$ geometric mean of 1000 organisms/100 ml and $< 10\%$ of the samples > 2000 organisms/100ml.
Solids	<u>All Classes:</u> These waters shall be free from floating, suspended, and settleable solids in concentrations or combinations that would impair any use assigned to each class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
Color and Turbidity	<u>All Classes:</u> These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use.
Oil & Grease	<u>Class A, SA:</u> Waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants. <u>Class SA:</u> Waters shall be free from oil and grease and petrochemicals. <u>Class B, C, SB, SC:</u> Waters shall be free from oil and grease, petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course or are deleterious or become toxic to aquatic life.
Taste and Odor	<u>Class A, SA:</u> None other than of natural origin. <u>Class B, C, SB, SC:</u> None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to each class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.
Aesthetics	<u>All Classes:</u> All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
Toxic Pollutants ~	<u>All Classes:</u> All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife... The division shall use the recommended limit published by EPA pursuant to 33 USC 1251, 304(a) as the allowable receiving water concentrations for the affected waters unless a site-specific limit is established.
Nutrients	Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication.

*Class BCWF = Class B Cold Water Fishery, ** Class BWWF = Class B Warm Water Fishery, Δ criterion (referring to a change from ambient) is applied to the effects of a permitted discharge. ~ EPA. 19 November 1999. Federal Register Document. [Online]. United States Environmental Protection Agency. <http://www.epa.gov/fedrgstr/EPA-WATER/1998/December/Day-10/w30272.htm>.

Designated Uses

The Massachusetts Surface Water Quality Standards designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected. Each of these uses is briefly described below (DEP 1996):

- **AQUATIC LIFE** - suitable habitat for sustaining a native, naturally diverse, community of aquatic flora and fauna. Three subclasses of aquatic life are also designated in the standards for freshwater bodies; *Cold Water Fishery* - capable of sustaining a year-round population of cold water aquatic life such as trout, *Warm Water Fishery* - waters which are not capable of sustaining a year-round population of cold water aquatic life, and *Marine Fishery* - suitable for sustaining marine flora and fauna.
- **FISH CONSUMPTION** - pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or shellfish or for the recreational use of fish, shellfish, other aquatic life or wildlife for human consumption.
- **PRIMARY CONTACT RECREATION** - suitable for any recreation or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water. These include, but are not limited to, wading, swimming, diving, surfing and water skiing.
- **SECONDARY CONTACT RECREATION** - suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities.
- **DRINKING WATER** - used to denote those waters used as a source of public drinking water. They may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). These waters are designated for protection as Outstanding Resource Waters under 314 CMR 4.04(3).
- **AGRICULTURAL AND INDUSTRIAL** - suitable for irrigation or other agricultural process water and for compatible industrial cooling and process water.
- **SHELLFISH HARVESTING** (in SA and SB segments) – Class SA waters in approved areas (Open Shellfish Areas) shellfish harvested without depuration shall be suitable for consumption; Class SB waters in approved areas (Restricted Shellfish Areas) shellfish harvested with depuration shall be suitable for consumption.
- **AESTHETICS** - all surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

Other restrictions, which denote specific subcategories of use assigned to the segment that, may affect the application of criteria or specific antidegradation provision of 314 CMR 4.00 which are specified in segments of the North Coastal Watershed include:

- **Combined Sewer Overflow (CSO)** – These waters are identified as impacted by the discharge of combined sewer overflows in the classification tables in 314 CMR 4.06(3). The permitting authority without a variance or partial use designation may allow overflow events where the provisions 314 CMR 4.06(1)(d)10 are met. The waterbody may be subject to short-term impairment of swimming or other recreational uses, but support these uses through most of their annual period of use; and the aquatic life community may suffer some adverse impact yet is still generally viable).

The guidance used to assess each designated use follows.

AQUATIC LIFE USE

This use is suitable for sustaining a native, naturally diverse, community of aquatic flora and fauna. The results of biological (and habitat), toxicological, and chemical data are integrated to assess this use. The nature, frequency, and precision of the DEP's data collection techniques dictate that a weight of evidence be used to make the assessment, with biosurvey results used as the final arbiter of borderline cases. Excursions from criteria due to natural conditions are not considered impairment of use. The following chart provides an overview of the guidance used to assess the status (support, partial support, non support) of the *Aquatic Life Use*:

Variable (# indicates reference)	Support—Data available clearly indicates support. Minor excursions from chemical criteria (Table 3) may be tolerated if the biosurvey results demonstrate support.	Partial Support – Uncertainty about support in the chemical or toxicity testing data, or there is some minor modification of the biological community. Excursions not frequent or prolonged.	Non Support – There are frequent or severe violations of chemical criteria, presence of acute toxicity, or a moderate or severe modification of the biological community.
BIOLOGY			
Rapid Bioassessment Protocol (RBP) II or III (4)	Non-Impaired	Slightly Impaired	Moderately or Severely Impaired
Fish Community (4)	BPJ*	BPJ*	BPJ*
Habitat and Flow (4)	BPJ*	BPJ*	Dry Streambed due to artificial regulation or channel alteration
Macrophytes (4)	No non-native plant species present, BPJ	Non-native plant species present but not dominant, BPJ*	Non-native plant species dominant, BPJ*
Plankton/ Periphyton (4)	No algal blooms	Occasional algal blooms	Persistent algal blooms
TOXICITY TESTS			
Water Column (4)	>75% survival either 48 hr or 7-day exposure	>50 - ≤75% survival either 48 hr or 7-day exposure	≤50% survival either 48 hr or 7-day exposure
Effluent (4)	Meets permit limits	(NOTE: if limit is not met, the stream is listed as threatened for 1.0 river mile downstream from the discharge.)	
Sediment (4)	>75% survival	>50 - <75% survival	≤50% survival
CHEMISTRY- WATER			
DO (3, 6)	Criteria (Table 3)	Criteria exceeded in 11-25% of measurements.	Criteria exceeded >25% of measurements.
pH (3, 6)	Criteria (Table 3)	Criteria exceeded in 11-25% of measurements.	Criteria exceeded >25% of measurements.
Temperature (3, 6) ***	Criteria (Table 3), ***	Criteria exceeded in 11-25% of measurements.	Criteria exceeded >25% of measurements.
Turbidity (4)	Δ 5 NTU due to a discharge	BPJ*	BPJ *
Suspended Solids (4)	25 mg/L max., Δ10 mg/L due to a discharge	BPJ*	BPJ*
Nutrients (3) Phosphate-P (4)	Table 3, (Site-Specific Criteria; Maintain Balanced Biocommunity, no pH/DO violations)	BPJ*	BPJ*
Toxic Pollutants (3, 6) Ammonia-N (3, 4) Chlorine (3, 6)	Criteria (Table 3) 0.254 mg/L**** NH ₃ -N 0.011 mg/L TRC	Criterion is exceeded in ≤ 10% of samples.	Criterion is exceed in > 10% of samples.
CHEMISTRY – SEDIMENT			
Toxic Pollutants (5)	≤ L-EL*****	One pollutant between L-EL and S-EL	One pollutant ≥ S-EL
Nutrients (5)	≤ L-EL	between L-EL and S-EL	≥ S-EL
Metal Normalization to Al or Fe (4)	Enrichment Ratio ≤ 1	Enrichment Ratio >1 but ≤10	Enrichment Ratio ≥10
CHEMISTRY- EFFLUENT			
Compliance with permit limits (4)	In-compliance with all limits	NOTE: If the facility is not in compliance with their permit limits, the information is used to threaten one river mile downstream from the discharge.	
CHEMISTRY-TISSUE			
PCBs – whole fish (1)	≤500 µg/Kg wet weight	BPJ*	BPJ*
DDT (2)	≤14.0 µg/Kg wet weight	BPJ*	BPJ*
PCBs in aquatic tissue (2)	≤0.79 ng TEQ/Kg wet weight	BPJ*	BPJ*

*BPJ = Best Professional Judgement, ***maximum daily mean temp. in a month (minimum of 6 measurements evenly distributed over 24-hours) < criterion, ****Ammonia levels for pH of 9.0, actual "criterion" varies with pH and is evaluated case-by-case, *****L-EL = Low Effect Level and S-EL = Severe Effect Level

FISH CONSUMPTION USE

Pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or shellfish or for the recreational use of fish, shellfish, other aquatic life or wildlife for human consumption. This assessment is made using the most recent list of Fish Consumption Advisories issued by the Massachusetts Executive Office of Health and Human Services, Department of Public Health (MA DPH), Bureau of Environmental Health Assessment Fish Consumption Advisory List. Following is an overview of the guidance used to assess the status (support, partial support, non-support) of the fish consumption use.

Variable (# indicates reference)	Support —No restrictions or bans in effect	Partial Support —A "restricted consumption" fish advisory is in effect for the general population or a sub-population that could be at potentially greater risk (e.g., pregnant women, and children	Non Support —A "no consumption" advisory or ban in effect for the general population or a sub-population for one or more fish species; or there is a commercial fishing ban in effect
MA DPH Fish Consumption Advisory List (8)	Not applicable, precluded by statewide advisory (Hg)	Not applicable	Waterbody on MA DPH Fish Consumption Advisory List

* NOTE: In 1994, MA DPH issued a statewide *Interim Freshwater Fish Consumption Advisory* for mercury. This precautionary measure was aimed at pregnant women only; the general public was not considered to be at risk from fish consumption. The advisory encompasses all freshwaters in Massachusetts therefore the *Fish Consumption Use* will no longer be assessed as support.

DRINKING WATER USE

Drinking Water Use denotes those waters used as a source of public drinking water. These waters may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). They are designated for protection as Outstanding Resource Waters in 314 CMR 4.04(3). DEP's Drinking Water Program (DWP) maintains current drinking water supply data for active public water supplies. When a source has been placed on "emergency or backup" status no testing is required. The *Drinking Water Use* is not assessed in this report however, EPA guidance is provided below.

Variable (# indicates reference)	Support -- No closures or advisories (no contaminants with confirmed exceedences of MCLs, conventional treatment is adequate to maintain the supply).	Partial Support — Is one or more advisories or more than conventional treatment is required	Non Support — One or more contamination-based closures of the water supply
Drinking Water Program (DWP) Evaluation	Reported by DWP	Reported by DWP	Reported by DWP

SHELLFISHING USE

This use is assessed using information from the Department of Fisheries, Wildlife and Environmental Law Enforcement's Division of Marine Fisheries (DMF). The information is in the form of various classifications of shellfish closures and restrictions. Shellfish areas under management orders are *not* assessed.

Variable (# indicates reference)	Support – SA Waters—open for shellfish harvesting without depuration (Open areas) SB Waters—open for shellfish harvesting with depuration (Open, conditionally approved, restricted areas)	Partial Support – SA Waters—Seasonally closed, seasonally open, conditionally approved, conditionally restricted SB Waters—Seasonally closed, seasonally open, conditionally restricted areas	Non Support – SA Waters—Prohibited, areas SB Waters—Prohibited, areas
Division of Marine Fisheries Shellfish Project Classification Area Information (11)	Reported by DMF	Reported by DMF	Reported by DMF

PRIMARY CONTACT RECREATIONAL USE

This use is suitable for any recreational or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water (1 April to 15 October). These include, but are not limited to, wading, swimming, diving, surfing and water skiing. The chart below provides an overview of the guidance used to assess the status (support, partial support, non-support) of the primary contact use.

Variable (# indicates reference)	Support– Criteria are met, no aesthetic conditions that preclude the use	Partial Support – Criteria exceeded intermittently (neither frequent nor prolonged), marginal aesthetic violations	Non Support – Frequent or prolonged violations of criteria, formal bathing area closures, or severe aesthetic conditions that preclude the use
Fecal Coliform Bacteria (3, 9) *	Criteria met OR <u>Dry Weather Guidance</u> <5 samples—≤400/100 ml maximum <u>Wet Weather Guidance</u> Dry weather samples meet and wet samples ≤2000/100 ml	Guidance exceeded in 11-25% of the samples OR <u>Wet Weather</u> Dry weather samples meet and wet samples ≥2000/100 ml	Guidance exceeded in > 25% of the samples
pH (3, 6)	Criteria exceeded in ≤10 % of the measurements	Criteria exceeded in 11-25% of the measurements	Criteria exceeded in >25% of the measurements
Temperature (3)	Criteria met	Criteria exceeded 11-25% of the time	Criteria exceeded 25% of the time
Color and Turbidity (3, 6)	Δ 5 NTU (due to a discharge) exceeded in <10 % of the measurements	Guidance exceeded in 11-25% of the measurements	Guidance exceeded in >25% of the measurements
Secchi disk depth (10) **	Lakes - ≥1.2 meters (≥ 4')	Infrequent excursions from the guidance	Frequent and/or prolonged excursions from the guidance
Oil & Grease (3)	Criteria met	Criteria exceeded 11-25% of the time	Criteria exceeded >25% of the time
Aesthetics (3) Biocommunity (4)**	No nuisance organisms that render the water aesthetically objectionable or unusable; Lakes – cover of macrophytes < 50% of lake area at maximum extent of growth.	Lakes – cover of macrophytes 50-75% of lake area at their maximum extent of growth.	Lakes – cover of macrophytes >75% of lake area at their maximum extent of growth.

Note: Excursions from criteria due to natural conditions are not considered impairment of use. The Primary Contact Use support status can not be rated higher than Secondary Contact. * Fecal Coliform Bacteria interpretations require additional information in order to apply this use assessment guidance. Bacteria data results (fecal coliform) are interpreted according to whether they represent dry weather or wet weather (stormwater runoff) conditions. Accordingly it is important to interpret the amount of precipitation received in the subject region immediately prior to sampling and streamflow conditions. ** Lakes exhibiting impairment of the primary contact recreation use (swimmable) because of macrophyte cover and/or transparency (Secchi disk depth) are assessed as either *partial* or *non support*. If no fecal coliform bacteria data are available and the lake (entirely or in part) met the transparency (Secchi disk depth) and aesthetics guidance this use is *not* assessed.

SECONDARY CONTACT RECREATIONAL USE

This use is suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities. Following is an overview of the guidance used to assess the status (support, partial support, non-support) of the secondary contact use.

Variable (# indicates reference)	Support — Criteria are met, no aesthetic conditions that preclude the use	Partial Support —Criteria exceeded intermittently (neither frequent nor prolonged), marginal aesthetic violations	Non Support —Frequent or prolonged violations of criteria, or severe aesthetic conditions that preclude the use
Fecal Coliform Bacteria (4) *	<u>Dry Weather Guidance</u> <5 samples—≤2000/100 ml maximum >5 samples—≤1000/100 ml geometric mean ≤ 10% samples ≥2000/100 ml <u>Wet Weather Guidance</u> Dry weather samples meet and wet samples ≤4000/100 ml	<u>Wet Weather Guidance</u> Dry weather samples meet and wet samples ≥4000/100 ml	Criteria exceeded in dry weather
Oil & Grease (3)	Criteria met	Criteria exceeded 11-25% of the time	Criteria exceeded >25% of the time
Aesthetics (3) Biocommunity (4) **	No nuisance organisms that render the water aesthetically objectionable or unusable; Lakes — cover of macrophytes < 50% of lake area at their maximum extent of growth.	Macrophyte cover is between 50 – 75%	Macrophyte cover exceeds 75% of the lake area.

Note: Excursions from criteria due to natural conditions are not considered impairment of use. The *Secondary Contact Use* support status can not be higher than the *Aesthetics Use* status. * Fecal Coliform Bacteria interpretations require additional information in order to apply this use assessment guidance. Bacteria data results (fecal coliform) are interpreted according to whether they represent dry weather or wet weather (stormwater runoff) conditions. Accordingly it is important to interpret the amount of precipitation received in the study region immediately prior to sampling and streamflow conditions. ** In lakes if no fecal coliform data are available, macrophyte cover is the only criterion used to assess the secondary contact recreational use.

For the Primary and Secondary Contact Recreational uses the following steps are taken to interpret the fecal coliform bacteria results:

1. Identify the range of fecal coliform bacteria results,
2. Calculate the geometric mean (monthly, seasonally, or on dataset), (Note: the geometric mean is only calculated on datasets with >5 samples collected in a 30-day period.)
3. Calculate the % of sample results exceeding 400 cfu/100 mL,
4. Determine if the samples were collected during wet or dry weather conditions (review precipitation and streamflow data),
 - Dry weather can be defined as: No/trace antecedent (to the sampling event) precipitation that causes more than a slight increase in stream flow.
 - Wet weather can be defined as: Precipitation antecedent to the sampling event that results in a marked increase in stream flow.
5. Apply the following to interpret dry weather data:
 - ≤10% of the samples exceed criteria (step 2 and 3, above) assessed as Support,
 - 11-25% of the samples exceed criteria (step 2 and 3, above) assessed as Partial Support,
 - >25% of the samples exceed criteria (step 2 and 3, above) assessed as Non Support.

AESTHETICS USE

All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life. The aesthetic use is closely tied to the public health aspects of the recreational uses (swimming and boating). Below is an overview of the guidance used to assess the status (support, partial support, non-support) of the aesthetics use.

Variable (# indicates reference)	Support— 1.No objectionable bottom deposits, floating debris, scum, or nuisances; 2. objectionable odor, color, taste or turbidity, or nuisance aquatic life	Partial Support – Objectionable conditions neither frequent nor prolonged	Non Support – Objectionable conditions frequent and/or prolonged
Aesthetics (3)* Visual observation (4)	Criteria met	BPJ (spatial and temporal extent of degradation)	BPJ (extent of spatial and temporal degradation)

Note: Excursions from criteria due to natural conditions are not considered impairment of use.

For lakes, the aesthetic use category is generally assessed at the same level of impairment as the more severely impaired recreational use category (primary or secondary contact).

References

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NORTH COASTAL WATERSHED DESCRIPTION AND CLASSIFICATION

DESCRIPTION

The North Coastal Watershed (Figure 3) is located in northeastern Massachusetts where it is bordered by the Ipswich Watershed to the west and by the Boston Harbor (Mystic) Watershed to the south. In its northern most reaches it contains parts of the extensive Hampton and Seabrook saltmarshes, bordering the Merrimack River. Progressing southward, Cape Ann provides some of the most distinctive rocky features of the Massachusetts coastline. The lower North Shore coastline consists of peninsulas interspersed with embayments, pockets of salt marsh, and estuaries with offshore rocky islands. The Rumney Marshes, which includes all or portions of the Pines and Saugus Rivers and Diamond Creek, are located at the southern extreme of the watershed. The Saugus River estuary is a large and historically degraded saltwater ecosystem with vast areas of wildlife habitat. The construction of a major highway system that intersected the estuary was halted in the 1970's.

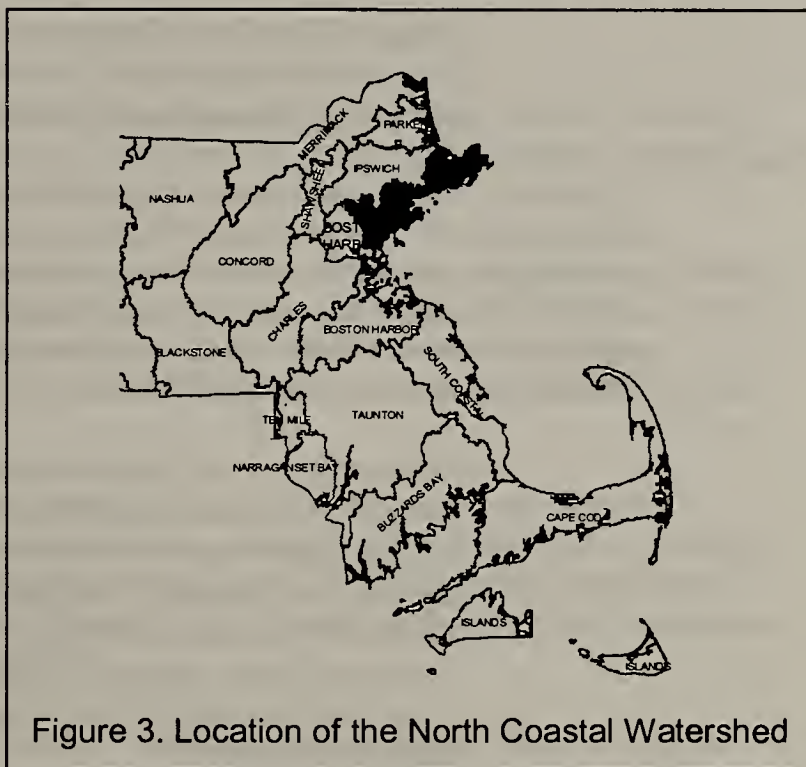


Figure 3. Location of the North Coastal Watershed

The North Coastal Watershed occupies much of the coastal region of Massachusetts' northshore. It extends from Salisbury to the city of Revere and comprises 168 square miles distributed over all or parts of 26 Massachusetts communities representing portions of Suffolk and Essex counties as well as one in New Hampshire. These are Salisbury, Amesbury, Revere, Everett, Malden, Melrose, Saugus, Stoneham, Reading, Wakefield, Lynnfield, Lynn, Nahant, Swampscott, Marblehead, Salem, Peabody, Danvers, Beverly, Manchester, Wenham, Hamilton, Essex, Ipswich, Gloucester, and Rockport. A small portion of Seabrook, New Hampshire also drains into the North Coastal Watershed. While the communities in the southern portions of the watershed are the most urban in character, almost all of the municipalities are densely populated.

A total of 89 lakes, ponds or impoundments (the term "lakes" will hereafter be used to include all) have been identified and assigned PALIS code numbers (Pond and Lake Information System, Ackerman 1989) in the North Coastal Watershed. Seventy of the lakes are less than or equal to 50 acres in total surface area; 50 are less than or equal to ten acres. The total surface open of the North Coastal Watershed lakes is 2,415 acres.

CLASSIFICATION

Consistent with the National Goal Uses of "fishable and swimmable waters", the classification of the North Coastal Watershed waters, according to the SWQS, include the following:

"Class SA – These waters are designated as an excellent habitat for fish, other aquatic life and wildlife and for primary and secondary recreation. In approved areas they shall be suitable for shellfish harvesting without depuration (Open Shellfishing Areas). These waters shall have excellent aesthetic value." In the North Coastal Watershed, the following waters are classified as SA:

- Essex River and its tributaries in Essex
- Annisquam River
- Pines River from its source to Route 1
- Walker Creek, Lanes Creek, Farm Creek, and Diamond Creek
- Essex Bay, Massachusetts Bay, and Nahant Bay
- Marblehead Harbor

"Class SB – These waters are designated as habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. In approved areas they shall be suitable for shellfish harvesting with depuration (Restricted Shellfishing Areas). These waters shall have consistently good aesthetic value." In the North Coastal Watershed, the following waters are classified as SB:

- Saugus River from Saugus Iron Works to Mouth.
- Pines River from Route 1 to mouth
- Rockport, Gloucester, Manchester, Beverly, Salem and Lynn Harbors

"Class A – These waters are designated as a source of public water supply. To the extent compatible with its use they shall be an excellent habitat for fish, other aquatic life and wildlife, and suitable for primary and secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters (ORW) under 314 CMR 4.04(3)" (Rojko et al 1995). In the North Coastal Watershed, the following waters are classified as A:

- Babson Reservoir, source to outlet in Gloucester and those tributaries thereto
- Haskell Pond, source to outlet in Gloucester and those tributaries thereto
- Goose Cove Reservoir, source to outlet in Gloucester and those tributaries thereto
- Dykes Pond, source to outlet in Gloucester and those tributaries thereto
- Wallace Pond, source to outlet in Gloucester and those tributaries thereto
- Fernwood Lake, source to outlet in Gloucester and those tributaries thereto
- Klondike Reservoir (Quarry Reservoir), source to outlet in Gloucester and those tributaries thereto
- Hawkes Pond, source to outlet in Lynnfield and those tributaries thereto
- Birch Pond, source to outlet in Saugus and Lynn and those tributaries thereto
- Breeds Reservoir, source to outlet in Lynn and those tributaries thereto
- Walden pond, source to outlet in Lynn and those tributaries thereto
- Gravelly Pond, source to outlet in Hamilton and those tributaries thereto
- Spring Pond, source to outlet in Peabody and those tributaries thereto
- Cape Pond, source to outlet in Rockport and those tributaries thereto
- Quarry Reservoir (Carlson's Quarry), source to outlet in Rockport and those tributaries thereto
- Crystal Lake, source to outlet in Wakefield and those tributaries thereto

"Class B – These waters are designated as habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Where designated they shall be suitable as a source of water supply with appropriate treatment. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value." In the North Coastal Watershed, the following waters are classified as B:

- Saugus River from its source (outlet of Lake Quannapowitt in Wakefield) to Saugus Iron Works including the LWSC Diversion Canal which discharges to Hawkes Pond (Treated Water Supply).
- Spring Pond and Griswold Pond from source to outlet in Saugus (also an ORW)

The designation of ORW is applied to those waters with exceptional socio-economic, recreational, ecological and/or aesthetic values (DEP 1995). ORWs have more stringent requirements than other waters because the existing use is so exceptional or the perceived risk of harm is such that no lowering of water quality is permissible. ORWs include certified vernal pools and all designated *Class A Public Water Supplies*, and may include surface waters found in National Parks, State Forests and Parks, Areas of Critical Environmental Concern (ACEC) and those protected by special legislation (MA DEM 1993). Wetlands that border ORWs are designated as ORWs to the boundary of the defined area. In the North Coastal Watershed, all designated ORWs are associated with *Class A Public Water Supplies*.

Unlisted waters in the North Coastal Watershed not otherwise designated in the SWQS, are designated *Class B, High Quality Waters* for inland waters and *Class SA, High Quality Waters* for coastal and marine waters. Where fisheries or shellfish designations are necessary they shall be made on a case-by-case basis.

NORTH COASTAL WATERSHED COMMUNITY

The North Coastal Watershed has been the subject of many studies in the past; hence, a great deal of information (data) is available from various interest groups. In addition to citizen organizations, various state agencies have monitoring programs in this watershed.

Three Local Governance Committees (LGCs) organized under the Massachusetts Bay National Estuary Program provide a prominent role in organizing and promoting citizen involvement. The three are: Salem Sound 2000, Eight Towns and the Bay and Metro Boston Local Governance Committee. These organizations, each described below, have been very active in this watershed and in some cases have sampling programs underway.

- Salem Sound 2000 (SS2000) is a non-profit, public-private partnership of municipalities, businesses, citizens and other non-profit organizations in a watershed defined region. They are unique in that each of the municipalities that border the Sound is formally represented in the organization. Their mission is to protect and enhance the quality of the Salem Sound ecosystem and to maximize its benefits as a regional resource.
- Eight Towns and The Bay (8T&B) is a committee of municipally - appointed citizens from the following communities: Salisbury, Amesbury, Newburyport, Newbury, Rowley, Ipswich, Essex, Gloucester and Rockport. 8T&B is dedicated to the protection of our coastal waters and associated watersheds on the upper north shore of Massachusetts Bay. The committee works to foster stewardship of coastal resources by heightening public awareness of solutions to pollution problems, providing technical assistance and supporting local research and education programs.
- The Metro Boston Local Governance Committee (previously known as Metropolitan Area Planning Council - MAPC) of the Massachusetts Bays Program is composed of two subgroups with a municipally appointed representative from each of twelve member communities. The subgroups were created to correspond with the boundaries of the EOEI Watershed Initiative and better enable the LGC to address issues using a watershed perspective. The Nahant Bay/Broad Sound Subgroup includes Swampscott, Lynn, Nahant, Saugus, and Revere, all of which fall within the North Coastal Watershed. The Boston Harbor Subgroup includes Winthrop, Everett, Chelsea, Boston, Milton, Quincy, and Braintree. Each Metro Boston subgroup works to address the priorities of the Mass Bays Program by bringing local representatives together to identify, discuss, and act on local and regional water quality and coastal resource issues. Five action items of the Massachusetts Bays Program's Comprehensive Conservation and Management Plan have become priorities for this committee: stormwater pollution control and prevention, shellfish resource protection, coastal habitat protection, local land use growth management, and managing municipal wastewater.

The Massachusetts Audubon Society is a voluntary association of people whose primary mission includes the preservation of a Massachusetts environment that supports both wildlife and people. The Society's programs encompass three broad areas: biological conservation, environmental education and advocacy. The Society is one of the largest independent conservation organizations in New England with a membership of 63,000 households. The Society's North Shore Conservation Advocacy office in Wenham serves the cities and towns on the North Shore. They focus their attention on the 16,000-acre "Great Marsh" of the upper North Shore and work closely with citizens, public officials, and local organizations to address issues of coastal habitat protection and restoration, water quality, and growth management.

The Saugus River Watershed Council is a nonprofit organization dedicated to educating, advocating and organizing for the protection of the resources in the Saugus River Watershed. The Council has an

The Saugus River Watershed Council is a nonprofit organization dedicated to educating, advocating and organizing for the protection of the resources in the Saugus River Watershed. The Council has an extensive volunteer water monitoring initiative, offers free educational programs, produces a bi-monthly newsletter, has a small grants program to fund projects within the watershed, and acts a voice for the river.

The Office of Coastal Zone Management (CZM) of Executive Office of Environmental Affairs (EOEA) has authority over the coastal areas of Massachusetts under the federal Coastal Zone Management Act. CZM helps communities with harbor planning, monitoring, some wastewater issues, stormwater, and wetland and tideland issues. CZM also serves as a conduit for grants to communities and organizations to remediate nonpoint source pollution.

The State Sanitary Code (105 CMR- 445.000) requires that the water at public bathing beaches be tested for bacteria to protect the public from contracting infectious diseases while swimming. The vast majority of beach water quality testing is collected by local health departments or local organizations. Through the Massachusetts Department of Public Health's participation in the Comprehensive Conservation and Management Plan (CCMP) of the Massachusetts Bays Program, a bathing beach surveillance system was developed to assess public health and environmental quality issues (MA DPH 1997). Their report summarizes 1995 bathing beach testing data.

Metropolitan District Commission (MDC) was created in 1893 to oversee the Metropolitan Park System. It now maintains over 19,000 acres of woodlands, wetlands, and urban parklands in eastern Massachusetts, as well as a 120,000 acre watershed and reservoir system that begins at Quabbin Reservoir. In the Saugus River Watershed, MDC's two largest parklands are Breakheart and Rumney Marsh Reservations. Routine testing for fecal coliform and enterococcus bacteria at their recreational beaches is conducted each year during the recreational season as part of their Beach Testing Program.

The Department of Fisheries, Wildlife and Environmental Law Enforcement, Division of Marine Fisheries, Shellfish Management Program classifies potential shellfish habitat for harvest and direct human consumption. The Division maintains a network of bacteria monitoring stations that provide data that are used to make classification determinations.

REVIEW OF EXISTING CONDITIONS AND PERCEIVED PROBLEMS

Nearly half (45%) of the land area in the North Coastal Watershed is highly developed, including residential, commercial, industrial and transportation land-use types. Most of these areas are served by municipal wastewater collection systems that deliver sewage to publicly owned treatment works (POTWs) which discharge into the watershed's coastal waters. However, many residences continue to rely on individual on-site septic systems for sewage disposal. Combined sewer overflows, non and/or contact cooling water and water treatment facility backwash wastewaters represent other types of discharges into the North Coastal Watershed. Sections of the North Coastal Watershed in Danvers, Lynn, Salem, Gloucester, Peabody and Saugus have extensive areas of impervious surfaces created by dense housing developments, roads, commercial and industrial development and parking areas. The runoff from these areas is altering the water quality and biological integrity of the resources that have been historically noted for smelt fishing, swimming and shellfishing.

The DEP DWM has conducted water quality surveys in the North Coastal Watershed since 1975. Prior to the 1997/1998 survey, the most recent surveys were conducted in 1987 and 1988 for Salem and Beverly Harbors and their tributaries, Salem Sound and Marblehead Harbor, Manchester Harbor, Gloucester Inner and Outer Harbors and a segment of the Annisquam River. Data from the 1987 survey indicated that high coliform bacteria densities and/or low dissolved oxygen impaired the North River, Goldthwait Brook, South River Channel, Crane River, Bass River, Salem Sound (at the WWTP outfall) and several coves of Inner Gloucester Harbor. Results of the 1988 survey indicated that the waters of the North Coastal Watershed generally did not support their designated uses (MA DEQE 1989).

The Clean Water Act section 303(d) requires states to identify those waterbodies that are not expected to meet Surface Water Quality Standards (SWQS). Thirteen lakes and ponds in the North Coastal drainage area were listed on the 1996 303(d) list: Beck Pond, Browns Pond, Chebacco Lake, Coy Pond, Flax Pond,

Floating Bridge, Griswold Pond, Lower Pond, Pillings Pond, Lake Quannapowitt, Sluice Pond, Spring Pond, and West Pond (DEP 1998c). Causes of impairment include noxious aquatic plants, fecal coliform bacteria, and/or organic enrichment/low dissolved oxygen.

Water quality monitoring in the Saugus River system has most recently been conducted by the Saugus River Watershed Council (SRWC) which has a volunteer water quality monitoring program. The monitoring program follows recommendations made in a report produced by a consultant for the SRWC, Hudsonia Limited of New York (Tashiro *et al.* 1991). The SRWC has since found areas with low dissolved oxygen and elevated nitrate concentrations that may be impacting the biological communities throughout the river. Fecal coliform bacteria were also found during both dry and wet weather in levels exceeding water quality standards (Saugus River Watershed Council 1994). The headwaters of the Saugus River are degraded in part as a result of water flowing from Lake Quannapowitt, which is a eutrophic lake.

The high population density places demand on the water resources in the drainage basin for water supply, even though several municipalities actually derive their water supply from surface or groundwater sources outside of the North Coastal Watershed. One area of concern is the Saugus River system that is affected by low flow conditions caused in part by registered and permitted water withdrawals by the Lynn Water and Sewer Commission. Water is diverted from the Saugus River mainstem into Hawkes Pond, part of the LWSC Water Supply Reservoir system. Permitted and registered withdrawals of 10.21 MGD by the City of Lynn and a permitted withdrawal of 0.28 MGD by the Colonial Golf Course in Lynnfield contribute to a section of the Saugus River being dry (Cashins 1997).

SOURCES OF INFORMATION

Multiple local, state and federal agencies provided information used in the water quality assessment of the North Coastal Watershed. Department of Environmental Protection (DEP) contributing agencies include Bureau of Resource Protection and Bureau of Waste Prevention (Hazardous Waste Sites). Within the Bureau of Resource Protection, this reporting agency (Division of Watershed Management), and the Division of Municipal Services provided information for the assessment of the national goal and state uses. Specifically, water quality, habitat assessment, and biological data were provided by DEP DWM. Water withdrawal and discharge information was provided by the Watershed Permitting Program (Water Management Act, and National Pollutant Discharge Elimination System). The Drinking Water Program evaluates the status of the *Drinking Water Use* and this information is therefore not provided in this assessment report. A complete listing of DEP DWM publications is available at <http://www.magnet.state.ma.us/dep/brp/brppubs.htm> (DEP 1999a).

Additional contributing state agencies include Massachusetts Department of Public Health (MA DPH) and Department of Fisheries, Wildlife and Environmental Law Enforcement's Division of Marine Fisheries (DMF). MA DPH's fish consumption advisory list was used to assess the *Fish Consumption Use*. DMF provided information/data to assess the *Aquatic Life* and *Shellfishing* uses. Federal agencies contributing include the EPA (NPDES permits) and United States Geological Survey (USGS) (streamflow data).

In addition to governmental agencies, citizen monitoring groups provided valuable screening level data. These types of information may be used to indicate areas of degraded water quality, causes and sources of contamination. Two active monitoring groups in the North Coastal Watershed, Salem Sound 2000 and the Saugus River Watershed Council provided data to DEP DWM. Although the data did not meet EPA and DEP DWM's stringent data quality objectives, the information provided was an integral part of the assessment process.

The DMF, Sportfisheries/Technical Assistance Program conducted a field sampling program between 1988 and 1990 to monitor rainbow smelt (*Osmerus mordax*) populations in coastal river systems along Massachusetts Bay (Chase 1990, 1992, 1993, 1995, and Chase *et al.* 1994). Smelt migrate from coastal waters into estuaries in the fall, provide a valuable fall and winter fishery in communities along the coast and spawn past the extent of saltwater encroachment in the increased flow of shallow riffles. The purpose of the program was to 1) provide baseline data useful to resource management goals of protecting sensitive spawning habitat from further degradation and restoring the Commonwealth's rainbow smelt populations and 2) to characterize river systems by the collection of baseline chemistry and document the occurrence of other diadromous species in the river systems. The results of these surveys in the North

occurrence of other diadromous species in the river systems. The results of these surveys in the North Coastal Watershed were provided by DMF. The reports were used to better delineate Class B (freshwater vs. SB - tidally influenced), provide specific recommendations to improve and/or protect smelt spawning habitat in the North Coastal Watershed, provide information for the assessment of the *Aquatic Life* and *Aesthetics* uses. Data from the DMF smelt spawning surveys are presented on a segment level, in this water quality assessment report. The results of surveys conducted in the North Coastal Watershed in streams not assessed in this report are described below (Chase 1990, 1992, 1993, 1995, and Chase *et al.* 1994).

In addition to the smelt survey, DMF conducted bacteria monitoring as part of their Shellfish Management Program. This information is used to classify (e.g., approved, conditionally approved, prohibited) and delineate their management areas. These classifications are subsequently used to regulate the harvesting of various shellfish (Churchill 1999). DMF shellfish management areas include acreage not designated as segments in this assessment report. Therefore the use support status in each segment is not inclusive of all North Coastal Watershed management areas. Appendix F includes the complete listing (watershed-wide) of DMF shellfishing closures posted in January 1999. This list was applied on a segment level to assess the *Shellfishing Use*.

DMF conducted a special investigation under their Sportfisheries/Technical Assistance Program from January-December 1997 entitled *A Study of the Marine Resources of Salem Sound, 1997*. The inventory and documentation of the status of marine fishery resources and water quality in Salem Sound during 1997 was used in this assessment report on a segment level where applicable (*Aquatic Life* and *Recreational* uses). Stations in the DMF study overlapping with segments in this report include: Sawmill Brook, Bass, Porter, Waters, Crane, Danvers, North, and Forest rivers, Manchester, Beverly, and Salem harbors and Salem Sound (Chase 2000). A brief summary of those areas surveyed by DMF not included in this assessment report is provided below.

ESSEX BAY SYSTEM

DMF conducted a smelt spawning habitat monitoring program in Walker Creek in 1989 and 1990 (Chase 1990). Although there was no evidence of smelt spawning during either sampling season, because of the good water quality and suitable spawning, Walker Creek has potential as a site for future smelt restoration projects.

ANNISQUAM RIVER SYSTEM

DMF conducted a smelt spawning habitat monitoring program in the Annisquam River system. All freshwater inputs were inspected for the presence of smelt eggs. Smelt spawning was only documented in the culvert below Route 133 in the Little River (Chase 1990). The overall available habitat for spawning is less than 50 meters and is vulnerable to discharges from the nearby water filtration plant and street runoff.

MANCHESTER HARBOR

DMF conducted a smelt spawning habitat monitoring program in the Manchester Harbor system. Smelt spawning was documented in Cat Brook (referred to as Sawmill Brook in Chase 1995) over a 98m stretch in the vicinity of School Street. Spawning was also documented in "Bennett Brook" (a locally named stream) and Chubb Creek. Approximately 300 m² of spawning habitat was available in Bennett Brook while a much smaller area (58 m stretch of stream) located downstream of the Route 127 culvert was found in Chubb Creek. Minimizing road run-off (sand and pollutants) from Route 127 and Bennett Road are recommended by DMF (Chase 1995). DMF conducted a smelt spawning habitat monitoring program in the Manchester Bay system between 1988 and 1990.

NORTH RIVER SUBWATERSHED

DMF investigated smelt spawning habitat in the North River system (Proctor Brook) although no evidence of smelt spawning was found in 1988.

SAUGUS RIVER SUBWATERSHED

Shutes Brook is a small freshwater tributary that originates in the wetlands west of western Saugus and flows easterly to join the estuarine portion of the Saugus River between Hamilton and Lincoln Avenue. Smelt spawning was documented by DMF (Chase 1992) downstream from the Central Street culvert. The total area used for spawning was estimated to be 810 m². Although smelt spawning was documented, DMF indicates that the habitat was impacted by anthropogenic influences. Poor water quality (turbidity associated with storm water runoff, elevated fecal coliform bacteria counts, observances of oil sheens associated with spills and highway runoff, and the dumping of trash from Central Street) all threaten and/or degrade the smelt spawning habitat in Shute Brook.

National Pollutant Discharge Elimination System (NPDES) permit files were reviewed to determine whether facilities were required to collect any ambient monitoring data which could supplement the analysis of water quality conditions in the North Coastal Watershed (DEP 1999b, 1999c, and 1999d). Where information was collected, it was used in the segment assessments that follow. However some facilities that are located in the North Coastal Watershed area actually discharge into waters not assessed in this report. These facilities are briefly described below:

1. MA0025707 Twin Light Manor Motor Inn, Gloucester discharge of 0.002 MGD to the Atlantic Ocean was to have been eliminated by 1 Oct 1975. Record of Title V violations in the permit file.
2. MA0025500 Easterly Inn, Gloucester discharge of 0.0035 MGD to the Atlantic Ocean. Information in permit file indicates Easterly Inn was going to tie into the Gloucester WWTP. Current status is unknown.
3. MA0100625 The city of Gloucester has a primary wastewater treatment facility under 301h waiver authority which discharges outside of Gloucester Harbor proper into the Atlantic Ocean
4. MA0100145 The Rockport WWTP discharges 0.8 MGD of treated municipal wastewater to Sandy Bay. Sandy Bay is outside of Rockport Harbor proper.
5. MA0090654 The town of Rockport Cape Ann Lighthouse discharges 0.0012 MGD of treated sanitary wastewater to the Atlantic Ocean from the facility on Thatchers Island, which is approximately one mile east of Rockport. (This permit was issued July 1982). Current status is unknown.
6. MAG640021 Town of Rockport water treatment facility discharge to Cape Pond a Class A waterbody.
7. MAG640003 Town of Manchester-by-the-Sea discharge from the Gravelly Pond Water Treatment Facility to Gravelly Pond, a Class A waterbody. This discharge began in June 1998. The first two DMR reports indicated a total residual chlorine (TRC) concentration of 3 mg/L between April and June 1998 and a concentration of 1mg/L between July and September 1998.
8. MA0001830 Lynn Sand & Stone Company discharge of quarry water, cooling water, and concrete slurry to a lagoon adjacent to Foster's Dam Pond. This permit expired in December 1979 and apparently the facility is still operating under that permit.
9. MA0100374 The town of Marblehead is only allowed to discharge under emergency conditions from the Sargent Road Pump Station Overflow. The overflow is screened and chlorinated prior to discharge into Massachusetts Bay.

DEP GRANT AND LOAN PROGRAMS

The DEP grant and loan programs consist of federal funds from EPA as authorized by the Clean Water Act (sections 604B, 104(b)(3) and 319, and the Drinking Water State Revolving Fund (DWSRF) Set-asides). Other programs are derived through state appropriation. These include the state bond fund for research and demonstration and state loan programs for municipalities (state revolving loan fund (SRF)) and homeowners (community septic management program). Each of these programs provides an opportunity for watershed initiative planning and/or implementation. Other governmental agencies (CZM, EPA, etc.) also offer water quality related funding through grant and loan programs. For further information on DEP managed grant and loan programs refer to Appendix E of this report.

DEP REGULATORY PROGRAMS

Two regulatory programs are discussed in this report, 21E and Title V. Additional MA DEP regulatory programs which may effect waters in the North Coastal Watershed include: the Wetlands Protection Act, the Rivers Protection Act, the Clean Vessels Act, etc.

Massachusetts Oil And Hazardous Material Release Prevention Act (M.G.L.C. 21E)

Pursuant to the Massachusetts Contingency Plan (MCP), a 21E site is "any building, structure, installation, equipment, pipe or pipeline, including any pipe discharging into a sewer or publicly-owned treatment works, well, pit, pond, lagoon, impoundment, ditch, landfill, storage container, motor vehicle, rolling stock, or aircraft, or any other place or area where oil or hazardous material has been deposited, stored, disposed of or placed, or otherwise come to be located. The term shall not include any consumer product in consumer use or any vessel." The MCP (collectively 310 CMR 40.0000) are the regulations promulgated by the DEP to enforce M.G.L. c. 21E. Sites are investigated and cleaned up by the person or company required to do so under this law. A

complete listing of statewide 21E sites can be accessed through the DEP World Wide Web site (<http://www.state.ma.us/dep/bwsc/sitelist.htm>).

Title V

Department of Environmental Protection 310 CMR 479 - 310 CMR 15.000: of the State Environmental Code, Title 5: are the standard requirements for the siting, construction, inspection, upgrade and expansion of on-site sewage treatment and disposal systems and for the transport and disposal of septage (DEP 2000b).

OBJECTIVES

This report summarizes information generated in the North Coastal Watershed through *Year 1* (information gathering in 1996) and *Year 2* (environmental monitoring in 1997) activities established in the "Five-Year Cycle" of the Watershed Initiative. Data collected by DEP DWM in 1997/1998, in accordance with the Quality Assurance Project Plan (QAPP) (DEP 1998a), are provided in Appendix A, B, and C (QA/QC, data tables, technical memorandum of biological monitoring, respectively). Together with other sources of information identified in each segment assessment (e.g., EPA, DMF, etc.), the status of current water quality conditions of lakes and streams in the North Coastal Watershed was assessed in accordance with EPA's and DEP's use assessment methods. It is important to realize, however, that not all waters in the North Coastal Watershed are included in the DEP/EPA Water Body System database (WBS) (Dallaire 1999) or this report. Specifically, DMF manages shellfish growing areas that extend beyond the coastal segments contained in this report. A summary of all North Coastal Watershed shellfish growing areas is provided in Appendix F of this report.

The objectives of this water quality assessment report are to:

1. Evaluate whether or not individual segments currently meet water quality standards,
2. evaluate the status of each designated use that is applicable to the segment,
3. identify major point and nonpoint sources that could effect the segment (water withdrawals, wastewater discharges, land use practices, etc),
4. identify the presence or absence of any non-native macrophytes in lakes,
5. identify waters (or segments) of concern that require additional data to fully assess the water quality conditions, and
6. recommend additional monitoring needs and/or remediation actions in order to better determine the level of impairment or to improve/restore water quality.

SEGMENT REPORT FORMAT

The segment order in this assessment report begins with the northern most waters in the North Coastal watershed and proceeds down the Massachusetts coastline to the watershed boundary in Revere. Stream segments are organized hydrologically (from most upstream to downstream) and are described in river miles with tributary summaries following the segment into which they discharge. Marine segments (estuaries) are described in square miles and are presented hydrologically from north to south. Lake assessments are presented after the stream and estuary segments. Each segment summary is formatted as follows:

SEGMENT IDENTIFICATION

Name, water body identification number (WBID), location, length/area, and classification.

Sources of information: WBID database (Dallaire 1999) a coding system (waterbody identification number e.g., MA72-01) used by DEP to reference the stream segment in databases such as 305(b) and 303(d). Individual segment classification is defined in the SWQS (MA DEP 1996) and segment definitions in the Stream and River Inventory System, SARIS, (MA DEP 1982).

SEGMENT DESCRIPTION

Flow direction, tributary confluences, and other observations.

Sources of information: descriptive information from USGS topographical maps. Identification of 21 E sites in the North Coastal Watershed (MA DEP 1997) and DEP regulatory programs (Gil 2000).

WATER WITHDRAWALS AND WASTEWATER DISCHARGE PERMIT INFORMATION

WMA, NPDES, CSO and boat pump-out facilities.

Sources of information: WMA Database Printout (LeVangie 1997); open permit files located in Worcester, and Wilmington DEP Offices (MA DEP 1999b and 1999c); MassGIS (EOEA 1995a 1995b and 1997) maps (priority resources, water supply protection, and draft active NPDES sites), and Pumpout Facilities in the North Shore Region (MA DEP 2000a).

USE ASSESSMENT

Discussion of current reliable data/information.

Sources of information: recent DEP DWM survey data (Appendix A, B, and C) and the following: data from the DEP DWM Toxicity Testing Database "TOXTD" (Dallaire 1998), USGS streamflow data (Socolow *et al.* 1998, Socolow 1998 and Socolow *et al.* 1999), Department of Environmental Management (DEM) streamflow data (DEM 1998); DMF shellfish management area data (Churchill 1999); DMF Salem Sound marine resource data (Chase 2000); the MA DPH Freshwater Fish Consumption Advisory List (MA DPH 1998) and bacteria testing of marine beaches (MA DPH 1997) and Metropolitan District Commission fecal coliform bacteria data (G&L Laboratories 1998).

SUMMARY

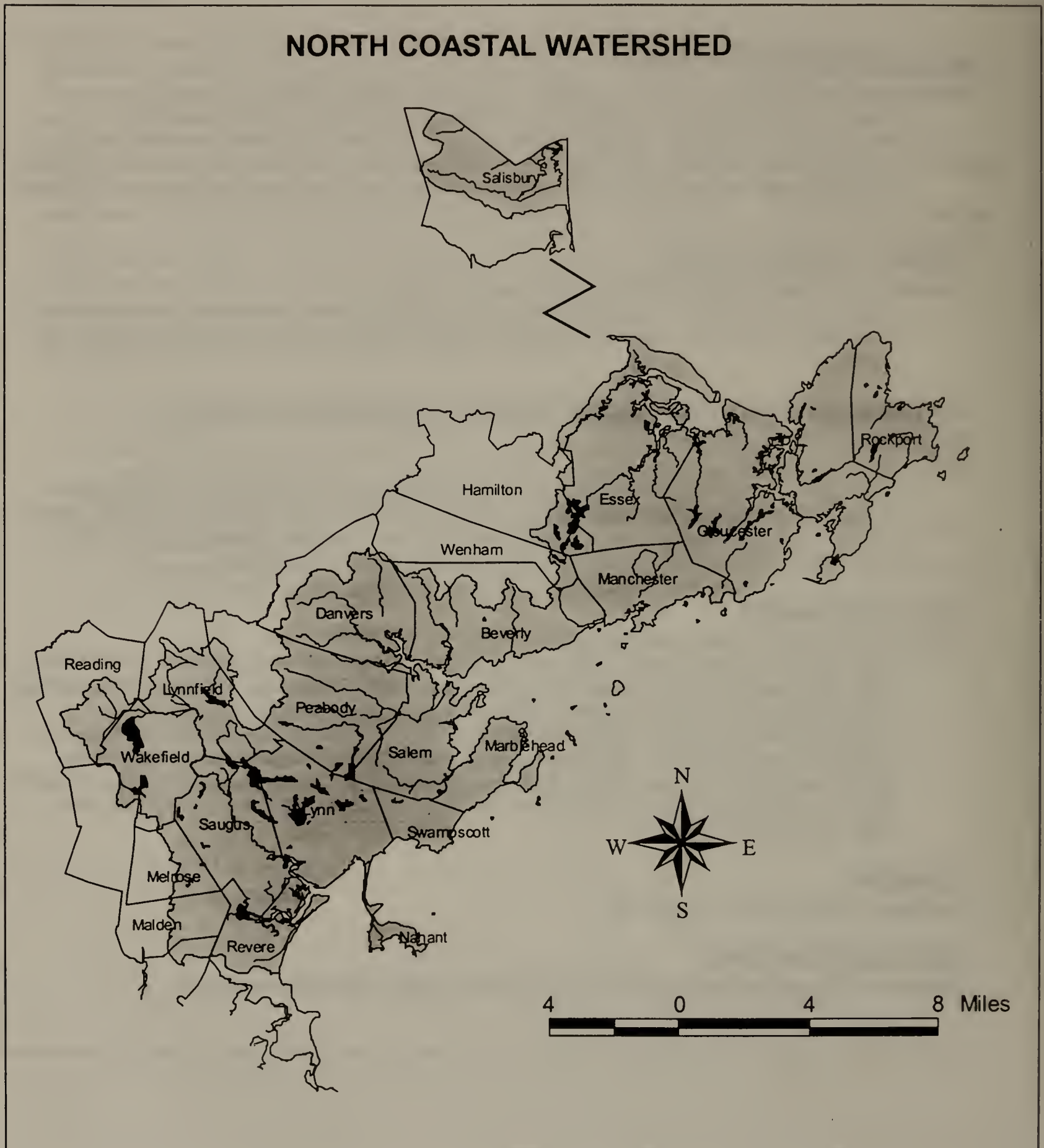
Use support status summary and table.

RECOMMENDATIONS

Additional monitoring and implementation requirements to assess the designated uses.

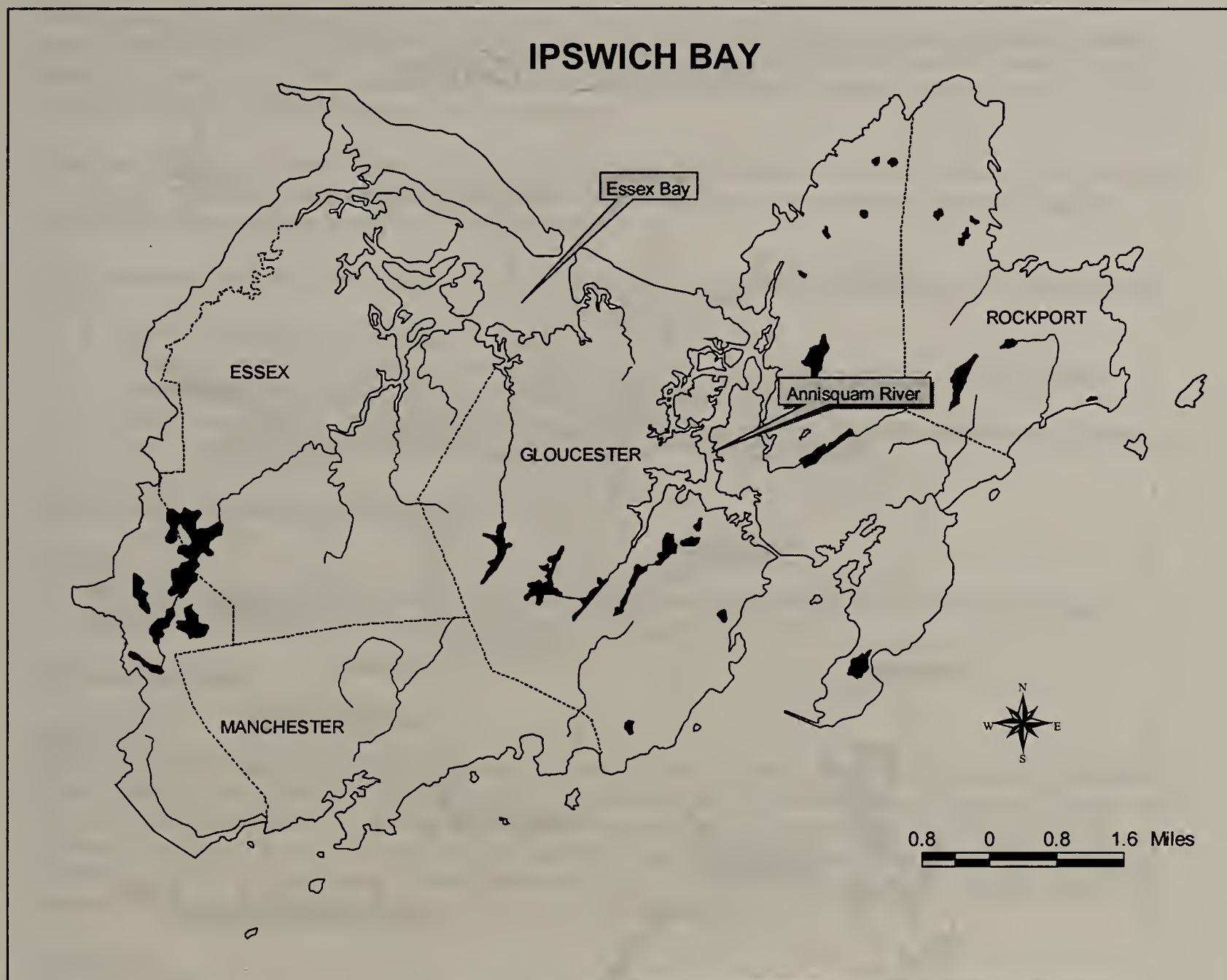
RIVERS AND COASTAL SEGMENTS

The organization of the river segments in this report begins with the northernmost area of the watershed and progresses through to the southern-most area. Since the North Coastal Watershed is comprised of a series of small watershed drainage systems, each watershed area is briefly described prior to the segment assessment summaries. No data is currently available on the northern most section of the North Coastal Watershed (Salisbury). Therefore there is no information or discussion provided for the North Coastal Watershed north of Essex.



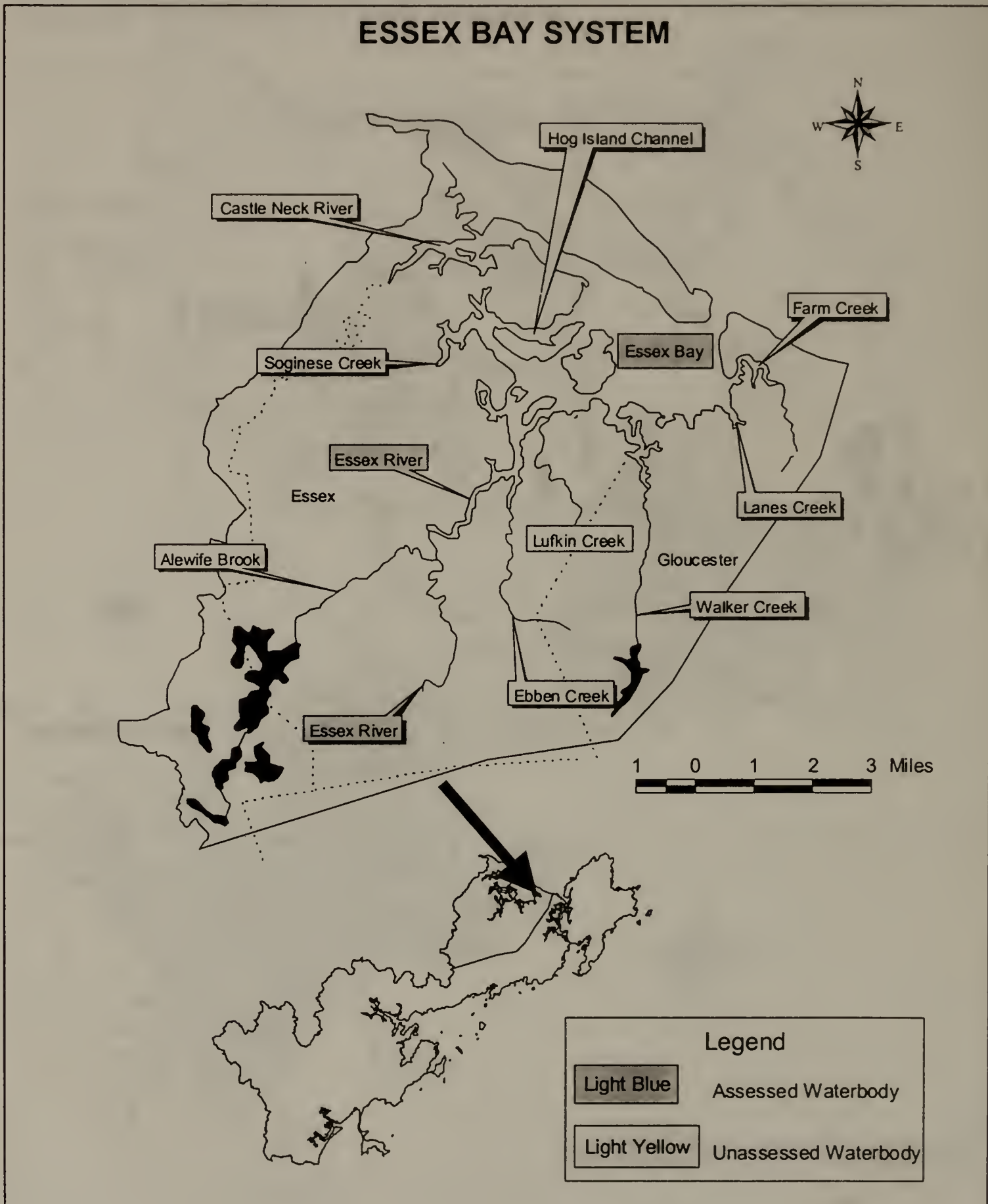
IPSWICH BAY

Two drainage systems discharge into Ipswich Bay from the North Coastal River Watershed—Essex Bay and the Annisquam River.



THE ESSEX BAY SYSTEM

The western drainage area of the Essex Bay system is comprised of Castle Neck Creek, Hog Island Channel, and the Essex River, which has four tributaries. The Essex River tributaries include Soginese Creek, Lufkin Creek, Ebben Creek and Alewife Brook. Walker Creek, Lanes Creek, and Farm Creek also discharge into Essex Bay along its southeastern shore. Assessments follow for the Essex River and Essex Bay.



ESSEX RIVER (SEGMENT MA93-11)

Location: Source east of Southern Avenue to mouth at Essex Bay, Essex. Length/area: 0.90 mi²
Classification: Class SA.

SEGMENT DESCRIPTION

This segment is a Class SA tidal estuary draining in a northerly direction into Essex Bay. As of 8 April 1997, a review of the Chapter 21E sites (hazardous waste sites) indicated five locations where minor spillage of petroleum or hazardous waste was reported including the following release tracking numbers: 3-0002981, 4552, 4723, 1464, and 3021 in this area.

The town of Essex is under an Administrative Order from DEP to address chronic water quality problems associated with failing septic systems. The town has conducted some monitoring and has recently initiated facilities planning to address this problem.

DEP managed grant and loan projects that should be improving water quality conditions in this segment include:

- SRF- Townwide Title V Repairs;
- 104B Project 94-05 – Dry and wet weather effects of storm drain systems on selected MA shellfish areas: the first step in correcting the problem – Essex coastal waters;
- 604B Project 96-02 - Project entitled Assessment of On-site Sewage Disposal Related Pollution in Gloucester Waters (Buchsbaum and Holt 1998).

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0029564 Essex Housing Authority is authorized to discharge 0.015 MGD of treated sanitary wastewater from a 40 unit elderly housing complex to the Essex River.

USE ASSESSMENT

Aquatic Life

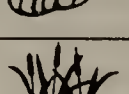
Division of Marine Fisheries (DMF) conducted a smelt spawning habitat monitoring program in the Essex River in 1990 (Chase 1990). The Essex River most likely once supported the most productive smelt run in the North Coastal Watershed. Presently, the run is so depleted that few fishermen bother to set up shacks on the river. Only a few eggs were found in the vicinity of the Town Dump culvert and additional sampling in 1991 was supposed to have been conducted. Chase (1990) also notes that the large run of alewives in the Essex River continues to spawn in Chebacco Lake.

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that the area N7.0 is conditionally approved and areas N7.2 and 7.3 are closed to shellfishing (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as partial support for 0.72 mi² and non-support for 0.18 mi².

SUMMARY

Due to the lack of current water quality data, only the status of the *Shellfishing Use* has been evaluated. The *Shellfishing Use* is assessed as partial support for a 0.72 mi² area due to a conditional approval status and is non-support for 0.18 mi² due to a closure.

Designated Uses		Status: Essex River MA93-11
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		PARTIAL SUPPORT. The use is partially supported in 0.72 mi ² due to a conditional approval status. NON-SUPPORT. The use is non-support for 0.18 mi ² due to a closure. For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Essex River MA93-11)

- When DMF completes their evaluation of smelt spawning habitat in the Essex River, follow-up on their recommendations to improve and/or protect smelt spawning habitat.
- Assess the results of the ongoing grant/projects mentioned above as to the improving of water quality conditions (reduction of bacteria, nutrient, toxic substance, and sediment loadings) through post implementation monitoring.
- Conduct fecal coliform bacteria monitoring during wet and dry weather conditions to assess the *Primary* and *Secondary Contact Recreational* uses.
- Determine the current status of the Essex Housing Authority (MA0029564) of their NPDES permit and evaluate compliance.

ESSEX BAY (SEGMENT MA93-16)

Location: Essex/Ipswich/Gloucester. Length/area: 1.15 mi². Classification: Class SA.

SEGMENT DESCRIPTION

This segment is a class SA tidal estuary that encompasses parts of three communities, Essex, Ipswich and Gloucester.

The town of Essex has entered into a consent judgement (#96-2209B) with the Commonwealth to address the discharge of pollutants from the town's storm drainage facilities into Essex coastal waters. A source of the pollutants has been identified as failing septic systems that are directly or indirectly tied into the storm drainage system. The town has been required by DEP to initiate facilities planning to address the septic system failures.

DEP managed grant and loan projects that should be improving water quality conditions in this segment include:

- SRF grant - Town-wide Title V Repairs;
- 104B Project 94-05 – Dry and wet weather effects of storm drain systems on selected MA shellfish areas: the first step in correcting the problem – Essex coastal waters;
- 604B Project 96-02 - Project entitled "Assessment of On-site Sewage Disposal Related Pollution in Gloucester Waters" (Buchsbaum and Holt 1998).

WITHDRAWALS AND DISCHARGES

None known.

USE ASSESSMENT

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that their areas in Essex Bay are conditionally approved (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as partial support.

SUMMARY

Due to the lack of current water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as partial support for the entire 1.15 mi² area due to a conditional approval status.

Designated Uses

Status: Essex Bay MA93-16

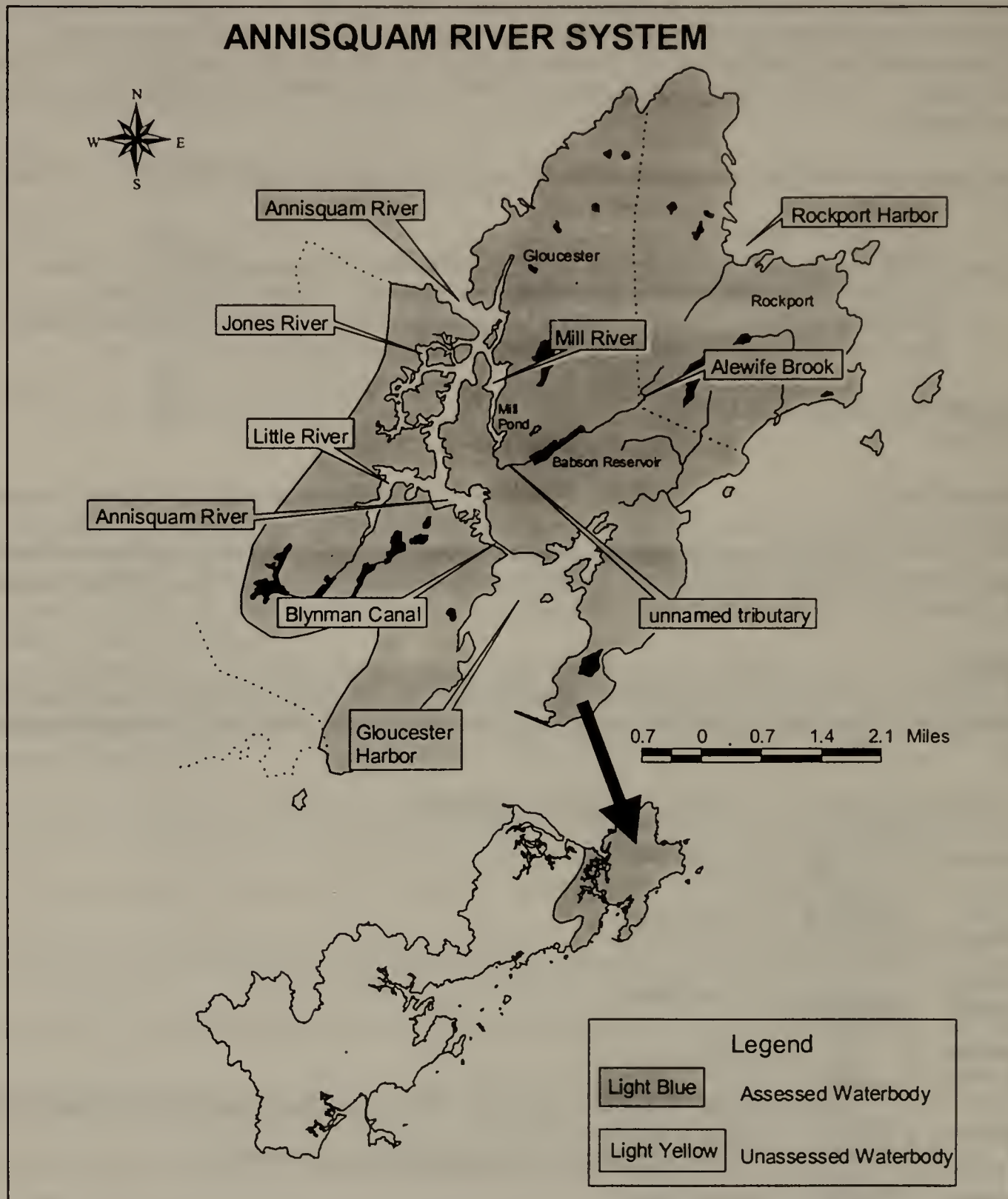
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		PARTIAL SUPPORT. The entire 1.15 mi ² area partially supports this use based on a DMF conditional approval. For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Essex Bay MA93-16)

- Assess the results of the ongoing grant/projects mentioned above as to the improving of water quality conditions (reduction of bacteria, nutrient, toxic substance, and sediment loadings) through post implementation monitoring.

THE ANNISQUAM RIVER SYSTEM

The Annisquam River system (which is also hydraulically connected to Gloucester Harbor through the Blynman Canal) includes the Jones River, Little River and the Mill River. The Mill River subwatershed is comprised of Alewife Brook, Babson Reservoir, an unnamed tributary between Babson Reservoir and Mill Pond, and the Mill River. Assessments follow for Alewife Brook, unnamed tributary, Mill River and the Annisquam River.



ALEWIFE BROOK (SEGMENT MA93-26)

Location: Headwaters, Rockport to inlet Babson Reservoir, and Gloucester. Length/area: 1.0 river miles.
Classification: Class A.

SEGMENT DESCRIPTION

This small perennial stream originates just north of the Boston & Maine Railroad in Rockport and flows south into Gloucester and then southwest and parallels the railroad to its confluence with Babson Reservoir. Since the reservoir is used for drinking water Alewife Brook is a Class A waterbody. Land use is comprised of primarily protected open space, although there is an industrial park in the drainage area.

WITHDRAWALS AND DISCHARGES

None known.

USE ASSESSMENT

Aquatic Life

DEP DWM sampled one water quality monitoring station (AL01) on one occasion in June 1997 (Appendix B, Table B3). Instream dissolved oxygen was extremely low (1.9 mg/L, 20% saturation) as was pH (5.3 SU); most likely a result of the low flow conditions. Attempts to sample in this stream the following month were unsuccessful due to low flow conditions.

On 23 June 1997 DEP DWM field reconnaissance of Alewife Brook identified the reach upstream from Babson Reservoir to be an excellent choice as a reference site for benthic macroinvertebrate biomonitoring. A wooded reach of this brook offered many good habitat qualities: riffles, rocky substrates, channel sinuosity, and an undisturbed riparian zone. On 29 July 1997 DEP DWM was not able to sample this reach because there was no flowing water (Appendix C).

Recreation

DEP DWM sampled one station (AL01) in June 1997 for fecal coliform bacteria. Bacteria counts were <20 cfu/100 mL in the one sample collected (Appendix B, Table B5).

SUMMARY

Due to the limited instream data, the entire length of Alewife Brook is not assessed for all uses (below) at this time.

Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Drinking Water*	Aesthetics
					

* The DEP Drinking Water Program (DWP) maintains current drinking water supply data.

RECOMMENDATIONS (Alewife Brook MA93-26)

- Since this stream discharges into Babson Reservoir which is a part of the Gloucester Department of Public Work's surface water supply (PWS #3107000-01S), additional fecal coliform bacteria sampling should be conducted as part of the DEP's Source Water Assessment Program (SWAP).
- Determine if anthropogenic influences (e.g., undocumented water withdrawals) may be contributing to the water quantity issues in Alewife Brook or if the conditions in the brook are naturally occurring.

UNNAMED TRIBUTARY (SEGMENT MA93-27)

Location: Outlet Babson Reservoir, Gloucester to inlet of Mill Pond, Gloucester. Length/area: 0.7 river miles. Classification: Class B.

SEGMENT DESCRIPTION

This Class B segment flows in a generally southwesterly direction from the outlet of Babson Reservoir into Mill Pond in Gloucester.

WITHDRAWALS AND DISCHARGES

WMA:

1. Registration #31810701, Permit #9P31810701 for the Gloucester Department of Public Works, Gloucester. The Gloucester Department of Public Works is registered for withdrawal of 3.38 MGD and permitted for an additional 0.37MGD for a total of 3.77 MGD from seven surface water reservoirs.

USE ASSESSMENT

Aquatic Life

On 23 June 1997 DEP field personnel observed no water flowing out of Babson Reservoir. The Babson Reservoir outlet channel contained water but it appeared stagnant (Appendix C).

SUMMARY

All designated uses (below) in this Unnamed Tributary are not assessed at this time due to the lack of data.

Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
				

RECOMMENDATIONS (Unnamed Tributary MA93-27)

- Determine the quantity of water withdrawn by Gloucester Department of Public Works from Babson Reservoir (PWS #3107000-01S) and establish if this water withdrawal impacts the flow regime of this tributary. Conduct a review of the Gloucester Department of Public Works WMA registration and permit to minimize water withdrawals via water conservation measures and any other permit conditions to maximize flow into this tributary.

MILL RIVER (SEGMENT MA93-28)

Location: Outlet of Mill Pond, Gloucester to the confluence with the Annisquam River, Gloucester.
Length/area: 0.09 mi². Classification: Class SA.

SEGMENT DESCRIPTION

This segment is a Class SA tidal estuary in central Gloucester.

The city of Gloucester is also under a joint federal/state Administrative Order to correct on-site failing septic systems in the North Gloucester area. The city has aggressively tackled the on-site problems, implemented a Wastewater Management Plan and received funding through the Commonwealth's State Revolving Fund (SRF) grant program.

DEP managed grant and loan projects that should be improving water quality conditions in this segment include:

- three SRF projects (City-wide Title V, North Gloucester Pollution Abatement, and North Gloucester Experimental Area);
- 104B Project 94-05 – Dry and wet weather effects of storm drain systems on selected MA shellfish areas: the first step in correcting the problem;
- 319 (95-02) – A program to mitigate storm drain pollution impacting shellfish beds.

WITHDRAWALS AND DISCHARGES

NPDES

1. MA0100625 - the Riverside Avenue Pumping Station Bypass (outfall # 011) for the city of Gloucester is authorized to discharge 0.015 MGD at a frequency of 4 times per year.

USE ASSESSMENT

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that the area N9.3 is conditionally approved (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as partial support for 0.09mi².

Recreation

Sampling was conducted as part of a 604B Project 96-02 entitled 'Assessment of On-site Sewage Disposal Related Pollution in Gloucester Waters' (Buchsbaum and Holt 1998) at one station in the Mill River. The report also indicates improving water quality conditions (lower bacteria counts) in recent years (pre 1990 vs. post 1990 data).

SUMMARY

Due to the lack of current water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as partial support for the entire 0.09 mi² area due to a conditional approval status.

Designated Uses		Status: Mill River MA93-28
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		PARTIAL SUPPORT. The entire area (0.09 mi ²) partially supports this use (conditional approval). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Mill River MA93-28)

- The receiving water for the Riverside Avenue Pumping Station Bypass should be corrected in the city of Gloucester's NPDES permit by changing Annisquam River to Mill River upon EPA/DEP permit reissuance.
- If possible, eliminate the Pumping Station Bypass to stop the discharge of untreated wastewater to the Mill River.
- Assess the results of the ongoing grant/projects mentioned above as to the improving of water quality conditions (reduction of bacteria, nutrient, toxic substance, and sediment loadings) through post implementation monitoring.
- Determine whether or not the City of Gloucester has implemented innovative/alternative techniques as part of the Wastewater Management Plan to eliminate failing septic systems.

ANNISQUAM RIVER (SEGMENT MA93-12)

Location: Confluence with the Mill River, Gloucester to the mouth at Ipswich Bay, Gloucester.

Length/area: 1.90 mi². Classification: Class SA.

SEGMENT DESCRIPTION

This segment is a Class SA tidal estuary in north/central Gloucester. This segment begins in Gloucester Harbor and continues to Ipswich Bay. Chapter 21E sites in this area include: MAD0193819953, 0004180, 0004143, 0002130 and MAD9852780503, 0002090, 0004034, 0002035, 0003017, and 0000134.

The town of Gloucester is also under a joint federal/state Administrative Order to correct on-site failing septic systems in the North Gloucester area. The city has aggressively tackled the on-site problems, implemented a Wastewater Management Plan and received funding through the Commonwealth's State Revolving Fund (SRF) grant program.

DEP managed grant and loan projects that should be improving water quality conditions in this segment include:

- three State Revolving Funds (Town-wide Title V Repairs, North Gloucester Pollution Abatement and North Gloucester Experimental Area);
- 104B Project 94-05 Dry and wet weather effects of storm drain systems on selected MA shellfish areas: the first step in correcting the problem;
- 319 (95-02) program to mitigate storm drain pollution impacting shellfish beds.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0100625 The city of Gloucester Pumping Station Bypass at outfall #012 at Grant Circle is authorized to discharge 0.02 MGD at a frequency of 4 days/year and outfall #011 at Riverside Avenue Pumping Station Bypass is authorized to discharge 0.015 MGD at a frequency of 4 days/year.

Vessel sewage pump-out facility:

1. Cape Ann Marine, Gloucester.

USE ASSESSMENT

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that their areas in the Annisquam River are conditionally approved (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as partial support.

Recreation

Sampling was conducted as part of a 604B Project 96-02 entitled "Assessment of On-site Sewage Disposal Related Pollution in Gloucester Waters" (Buchsbaum and Holt 1998). The tributary systems to the Annisquam River including Little River, Jones River and the Rust Island system were also sampled. The report indicates improving conditions (pre 1990 vs. post 1990 data) and lower bacteria counts in Hucks Cove.

SUMMARY

Due to the lack of current water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as partial support for the entire 1.9 mi² area due to a conditional approval status.

Designated Uses		Status: Annisquam River MA93-12
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		PARTIAL SUPPORT. The entire 1.9 mi ² partially supports this use (conditionally approved). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Annisquam River MA93-12)

- Assess the results of the ongoing grant/projects mentioned above as to the improving of water quality conditions (reduction of bacteria, nutrient, toxic substance, and sediment loadings) through post implementation monitoring.
- Determine whether or not the City of Gloucester has implemented innovative/alternative techniques as part of the Wastewater Management Plan to eliminate failing septic systems.

ROCKPORT HARBOR (SEGMENT MA93-17)

Location: Rockport. Length/area: 0.02 mi². Classification: Class SB.

SEGMENT DESCRIPTION

This segment is a Class SB estuary located near downtown Rockport. For the purposes of this report, Rockport Harbor is defined as the waters inside of an imaginary line drawn between Bearskin Neck and the area called the Headlands. As of 15 April 1997, a review of the Chapter 21E sites indicates locations where minor spillage of petroleum or hazardous waste was reported. These include the following release tracking numbers in this area: 3-0010599, 3-0003841, 3-0001708, 3-0003397, 3-0004337, 3-0002528, 3-0001091, and MAD9810633813-0000425.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0100145--The Rockport WWTP discharges 0.8 MGD of treated municipal wastewater to Sandy Bay. Sandy Bay is outside of Rockport Harbor proper.
2. MA0090654—The town of Rockport Cape Ann Lighthouse discharges 0.0012 MGD of treated sanitary wastewater to the Atlantic Ocean from the facility on Thatchers Island, which is approximately one mile east of Rockport. (This permit was issued July 1982).

Vessel sewage pump-out facility:

1. Rockport Harbor, Rockport.

USE ASSESSMENT

Aquatic Life

The Rockport WWTP is under a Consent Order from DEP to repair their outfall pipe. Rockport is also under an Administrative Order restricting the number of new connections to the system except in the case of written authorization by the Board of Health. Although the WWTP discharges outside the harbor proper, the discharge may tidally effect this segment. Whole effluent acute toxicity testing was conducted on the WWTP's effluent using two test organisms (*Menidia beryllina* and *Mysidopsis bahia*). Between April 1994 and July 1997 a total of 10 test events were conducted with no acute toxicity detected by either test organism, although *M. bahia* appeared to be more sensitive (Dallaire 1998).

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that shellfishing is prohibited in area N11.1 (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support for this entire segment.

SUMMARY

Due to the lack of current water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as non-support for the entire 0.02 mi² area due to a prohibition.

Designated Uses

Status: Rockport Harbor MA93-17

Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 0.02 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Rockport Harbor MA93-17)

- Since *Mysidopsis bahia* is the more sensitive test organism to the Rockport WWTP effluent, it is recommended that the facility's toxicity testing requirements be reduced to only *M. bahia* in their next permit.
- DEP North East Regional Office (NERO) is working with the town to address long outstanding issues including the WWTP outfall pipe and street drains problems. Continue to monitor the repair process of the outfall pipe and the street-drain clean up.

GLOUCESTER HARBOR (SEGMENT MA93-18)

Location: Gloucester. Length/area: 2.24 mi². Classification: Class SB.

SEGMENT DESCRIPTION

This segment is a Class SB estuary in south Gloucester. For the purpose of this report, Gloucester Harbor is defined as the waters inside of an imaginary line drawn between Dog Bar Breakwater and Mussel Point. Gloucester Harbor is the site of numerous (8) Chapter 21E sites due to the release of petroleum and/or hazardous waste (printout dated 15 April 1997).

The city of Gloucester is also under a joint federal/state Administrative Order to correct on-site failing septic systems in the North Gloucester area. The city has aggressively tackled the on-site problems, implemented a Wastewater Management Plan and received funding through the Commonwealth's SRF grant program.

DEP managed grant and loan projects that should be improving water quality conditions in this segment include:

- SRF- City-wide Title V Repairs
- 604B Project 96-02 entitled Assessment of On-site Sewage Disposal Related Pollution in Gloucester Waters (Buchsbaum and Holt 1998);
- 104B Project 94-05 – Dry and wet weather effects of storm drain systems on selected MA shellfish areas: the first step in correcting the problem;
- 319 (95-02) – A program to mitigate storm drain pollution impacting shellfish beds.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0100625—The city of Gloucester has a primary wastewater treatment facility which discharges under a 301(h) waiver outside of Gloucester Harbor proper. It may, however, tidally effect this segment. Four CSO discharge locations as well as three pump station bypass outfalls also discharge directly into Gloucester Harbor as authorized by this NPDES permit. These outfalls are summarized below:

Discharge Point	Description	Discharge Rate (MGD)	Frequency (Days/Year)
002	Mansfield Street Drain Western Ave CSO	6.0	60
004	Rogers Street CSO	1.6	48
005	Main Street CSO	1.4	48
006	East Main Street CSO	1.4	48
003	Fort Square Bypass	0.025	4
007	State Fish Pier "tide gate"	0.025	6
008	Beacon Marine Bypass	0.015	4

USE ASSESSMENT

Aquatic Life

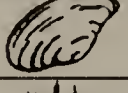
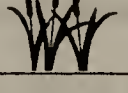
The city of Gloucester was required to implement a receiving water, biological and toxics control monitoring program as part of its 301(h) waiver. Monitoring has been required at a grid of eight stations within and outside of Gloucester Harbor, which included routine water quality measurements, benthic macroinvertebrate sampling in March and September, and sediment analysis. Currently the city of Gloucester is monitoring six stations for water quality parameters, all of which are outside the limits of this segment (Browne 1997).

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that shellfish harvesting in Gloucester Harbor is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

SUMMARY

Due to the lack of current water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as non-support for a 2.24 mi² area due to a prohibition.

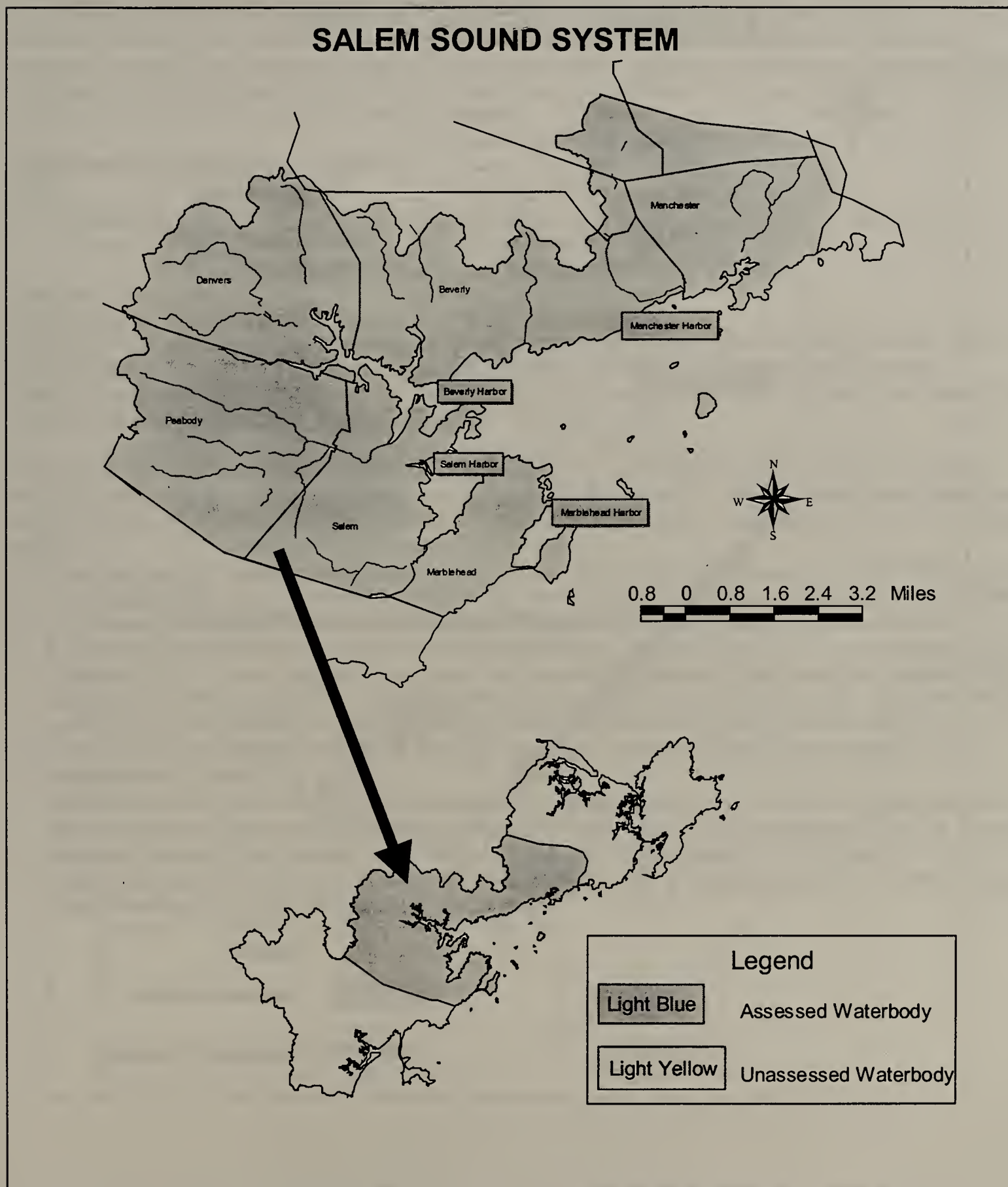
Designated Uses		Status: Gloucester Harbor MA93-18
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 2.24 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Gloucester Harbor MA93-18)

- Assess the results of the ongoing grant/projects mentioned above as to the improving of water quality conditions (reduction of bacteria, nutrient, toxic substance, and sediment loadings) through post implementation monitoring.
- Currently Dr. Allan Michael, a consultant to the City of Gloucester, collects water quality data for the 301(h) monitoring program. Evaluate these data in the next NPDES review/reissuance process to determine the impacts, if any, on water quality conditions.
- Request CZM assistance in the future interpretation of data for use in the 305(b) assessments, emphasizing the *Aquatic Life Use*.
- Determine whether or not the City of Gloucester has implemented innovative/alternative techniques as part of the Wastewater Management Plan to eliminate failing septic systems.

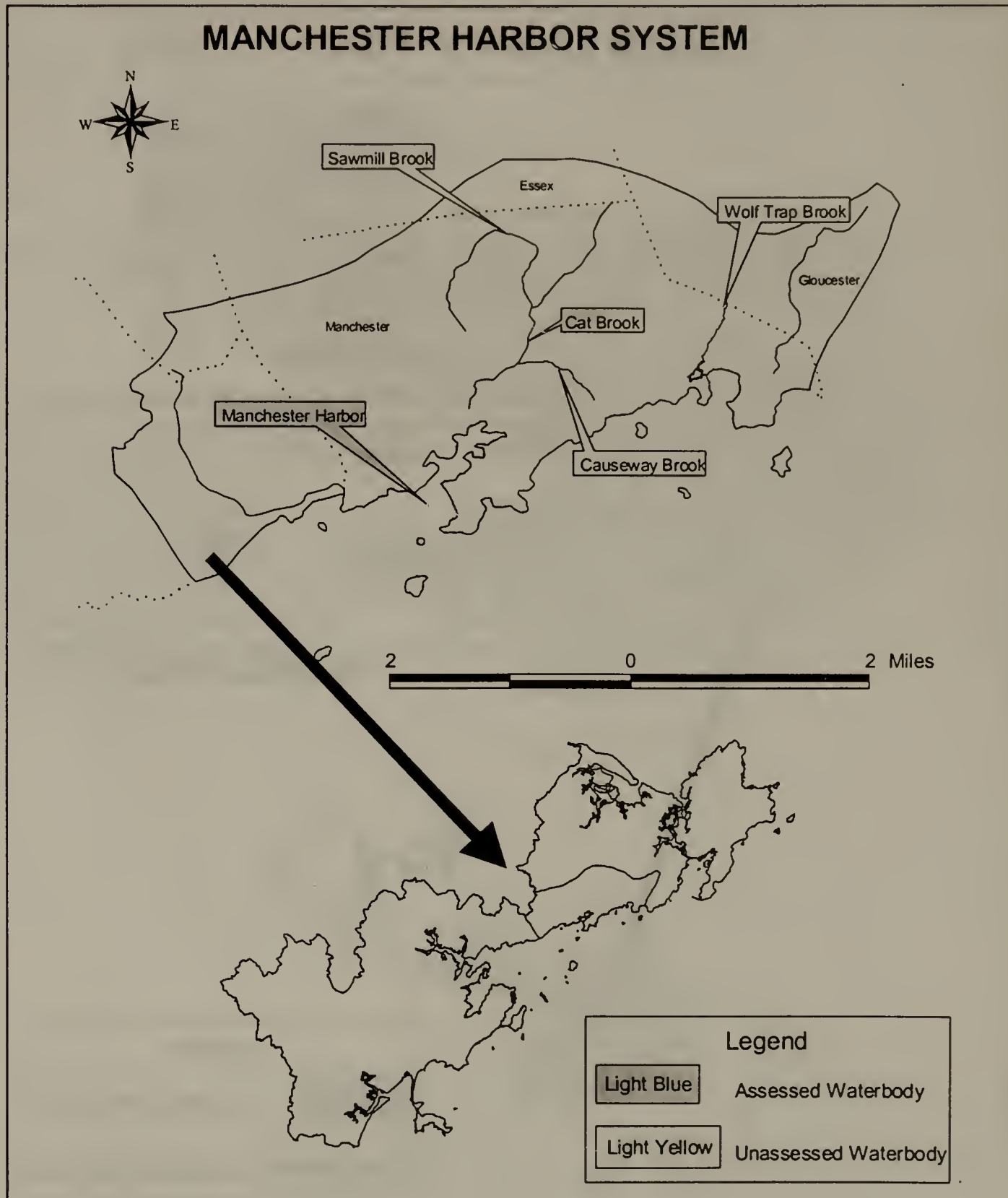
SALEM SOUND SYSTEM

The Salem Sound area is comprised primarily of four major systems. These include Manchester, Beverly, Salem and Marblehead Harbors. Excluding these four drainage systems, Salem Sound is broadly defined as the waters inside of an imaginary line drawn from Marblehead Light northeast to the southwestern point on Bakers Island, Beverly and from the northwestern point on Bakers Island to Gales Point, Manchester. Chubb Creek is the only named stream discharging directly to Salem Sound (MA DEP 1982).



MANCHESTER HARBOR SYSTEM

The Manchester Harbor system has two tributaries that flow into Manchester Harbor. These include Wolf Trap Brook and Cat Brook. Tributaries to Cat Brook include Causeway and Sawmill Brooks. The Massachusetts Stream Classification System (SARIS) identifies Sawmill Brook as a tributary to Cat Brook (DEP 1982). For the purposes of this assessment report, the stream reach from confluence of Sawmill and Cat brooks to Manchester Harbor is identified as Cat Brook. Assessments follow for Cat Brook and Manchester Harbor.



CAT BROOK (SEGMENT MA93-29)

Location: Headwaters north of Route 128, Manchester/Essex/Gloucester to confluence with Manchester Harbor, Manchester. Length/area: 2.5 river mile. Classification: Class B.

SEGMENT DESCRIPTION

Cat Brook, a Class B stream, flows southwest from its origin on the north side of Route 128 at the boundary of Manchester, Essex and Gloucester down through Manchester and into Manchester Harbor. Two named streams join it: Causeway and Sawmill brooks. Downstream from Sawmill Brook, Cat Brook is sometime referred to as Sawmill Brook. As of 15 April 1997, a review of the Chapter 21E sites (hazardous waste sites) indicate several locations where minor spillage of petroleum or hazardous waste was reported. These include the following release tracking numbers in this area: 3-0014131, 3-0014960, 3-0004415, 3-0012402, 3-0013104, and 3-0013099.

WITHDRAWALS AND DISCHARGES

WMA:

1. Registration #31816602 - Essex Country Club (Sawmill Brook Subwatershed) is registered to withdraw 0.1 MGD from the Essex Country Club reservoir.

USE ASSESSMENT

Aquatic Life

Potential smelt spawning habitat was documented by DMF during their 1989 and 1990 surveys. This study indicated that of the three Manchester Bay smelt runs, Cat Brook had the most available habitat/substrate for attachment and survival of eggs. The study also identified spawning activities to be below habitat capacity (Chase 1995).

DEP DWM monitoring was conducted downstream from the confluence of Cat and Sawmill brooks, at two stations as part of the 1997/1998 survey (Appendix B, Figure B2). Station SM01 was located near School Street and SM02 at Norwood Avenue. Complete data sets are presented in Appendix B, Tables B3 and B4.

- Dissolved oxygen measurements near School Street (SM01) ranged between 4.8 and 13.3 mg/L on the seven survey dates between June 1997 and March 1998 (Appendix B, Table B3). None of these DO measurements were collected before dawn, however, and do not represent worse-case conditions. During the sampling period DO was below water quality standards on one occasion (21 October 1997). The low measurement (4.8 mg/L and 42% saturation) was most likely related to the extremely low flow conditions. Sampling was also conducted on one occasion (29 July 1997) at SM02 and the percent saturation of DO was slightly below the state water quality standards (55%).
- Instream temperatures did not exceed 19.2°C. Total suspended solids did not exceed 7.5 mg/L (Appendix B, Table B3).
- DEP DWM's survey of other water quality variables (pH, alkalinity, and hardness) indicated that at times the stream had a limited buffering capacity. Instream pH levels were below 6.5 SU on 5 of the 8 sampling events. The measurements ranged from 5.0 to 6.6 SU (Appendix B, Table B3).
- Total phosphorus concentrations ranged from 0.02 mg/L to 0.11 mg/L while ammonia concentrations did not exceed 0.15 mg/L (Appendix B, Table B4).

During 1997 DMF sampled Sawmill Brook (also known as Cat Brook, upstream from School Street culvert) on 13 occasions as part of *A Study of the Marine Resources of Salem Sound, 1997* (Chase 2000).

- Dissolved oxygen concentrations ranged between 6.5 and 11.7 mg/L (no samples collected pre-dawn).
- Temperature readings did not exceed 19.1 °C. The instream pH ranged from 5.2 to 7.1SU. The median pH was 6.3 SU for the 11 sampling events indicating 50% of the measurements were below the SWQS for a Class B waterbody.
- Nutrient samples were collected on 12 occasions in 1997. The ammonia concentrations ranged from 0.00 to 0.294 mg/L.

DEP and USGS personnel conducted stream discharge measurements in Cat Brook near School Street (Appendix B, Table B2 and Socolow *et al.* 1998). Stream discharge ranged from 0.05 cfs (21 October 1997) to 19.3 cfs on 23 March 1998.

DEP conducted macroinvertebrate benthic biological monitoring on Cat Brook in July 1997 (Appendix C). At the time of sampling (29 July 1997) there was insufficient flow to conduct quantitative assessments, but qualitative samples were collected. Although the habitat was severely limited (low flow), the benthic community was diverse with nine identified families (Appendix C).

The *Aquatic Life Use* for Cat Brook is assessed as partial support due in part to low DO and low pH. This brook exhibited the lowest pH in the North Coastal Watershed with several measurements below 6.0 SU.

Recreation

DEP (same station as above water quality parameters) fecal coliform bacteria levels ranged from <20 to 920 cfu/100 mL (Appendix B, Table B5). Samples collected between 1 April and 15 October (the primary contact recreational "season") all exceeded 400 cfu/100 mL.

DMF collected fecal coliform bacteria samples from Sawmill Brook on 11 occasions in 1997, 8 of which were within the primary recreation season as part of *A Study of the Marine Resources of Salem Sound, 1997* (Chase 2000). From April 1st to October 15th counts ranged from 133 to >2400 cfu/100 mL. Fifty percent of the samples exceeded 200 cfu/100 mL. Dry weather conditions were identified on 25 June and 9 September 1997. On both dry weather sampling dates fecal coliform counts were elevated above the *Primary Contact Recreational Use* guidance (see Use Assessment Methods).

The *Primary Contact Recreational Use* is evaluated as non-support for the entire length of Cat Brook due to elevated fecal coliform bacteria levels. Because of the high fecal coliform bacteria level in August documented by DMF, the *Secondary Contact Recreational Use* is evaluated as partial support for the entire length of Cat Brook.

Aesthetics

DEP habitat assessment and field reconnaissance identified sedimentation, trash, and debris (DEP 1998d). These objectionable conditions resulted in the *Aesthetics Use* as being evaluated as partial support.

SUMMARY

The *Aquatic Life Use* is partial support for Cat Brook due to low DO (concentration and percent saturation) and low pH. Due to elevated levels of fecal coliform bacteria, the *Primary Contact Use* is not supported. The *Secondary Contact Recreational Use* is partially supported due to elevated fecal coliform bacteria counts.

Designated Uses		Status: Cat Brook MA93-29
Aquatic Life		PARTIAL SUPPORT. This use has been evaluated as partial support, due to low pH and DO for the entire length of Cat Brook.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 2.5 mile length of this stream does not support this use due to elevated levels of fecal coliform bacteria.
Secondary Contact		PARTIAL SUPPORT. The entire 2.5 mile length of this stream has been evaluated as partial support due to elevated levels of fecal coliform bacteria in August.
Aesthetics		PARTIAL SUPPORT. The entire 2.5 mile length of this stream has been evaluated as partial support based on sedimentation, trash and debris.

RECOMMENDATIONS (Cat Brook MA93-29)

- DMF (Chase 1995) recommends that all road work and land development in the Cat Brook watershed be conducted with consideration to minimize sediment and pollution run-off into the brook. Additionally, the Central Street dam at the mouth of Manchester Harbor obstructs smelt passage except during above average high tide conditions. Local officials should determine what tidal elevations are required to allow smelt passage over the lip of the dam and consider scheduling flood gate openings at these elevations during the smelt spawning run to facilitate passage.
- Salem Sound 2000's volunteer monitoring program identified elevated fecal coliform bacteria levels in Cat Brook that could potentially be attributed to illegal sewer connections. DEP DWM subsequently sampled Cat Brook and confirmed the high levels of bacteria. Therefore, illegal sewer connections need to be identified and corrective actions taken.
- The pH measurements in this brook were the lowest in this watershed and therefore are probably not naturally occurring. Conduct a comprehensive stream survey including an inventory of wastewater practices to determine the cause of low pH. Determine if there are any undocumented dischargers to the Cat Brook subwatershed.
- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).
- Determine the quantity of water withdrawn by Essex Country Club (Registration #31816602) and establish if this water withdrawal impacts the flow regime of this brook. Conduct a review of the Essex Country Club WMA registration to minimize water withdrawals via water conservation measures.

MANCHESTER HARBOR (SEGMENT MA93-19)

Location: Manchester. Length/area: 0.29 mi². Classification: Class SB.

SEGMENT DESCRIPTION

This is a Class SB estuary. For the purpose of this report, the harbor is defined as the waters inside of an imaginary line drawn across the narrows at Proctor Point. A review of the Chapter 21E file dated 14 April 1997 lists the following release tracking number sites: 3-0003657, 3-0003248, 3-0004415, and 3-0003806.

WITHDRAWALS AND DISCHARGES

Vessel sewage pump-out facilities:

1. Manchester Marina, Manchester.
2. Crocker's Boat Yard, Manchester.

USE ASSESSMENT

Aquatic Life

As part of the DMF *Study of the Marine Resources of Salem Sound, 1997*, beach seining was conducted at Proctor Point on 16 occasions from May-December (Chase 2000). The population was dominated by *Menidia menidia* (Atlantic silverside) and *Brevoortia tyrannus* (Atlantic menhaden).

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that their area (N15) in Manchester Harbor is prohibited (Churchill 1999) therefore the *Shellfishing Use* is assessed as non-support.

SUMMARY

Due to the lack of current water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as non-support for a 0.29 mi² area due to a prohibition.

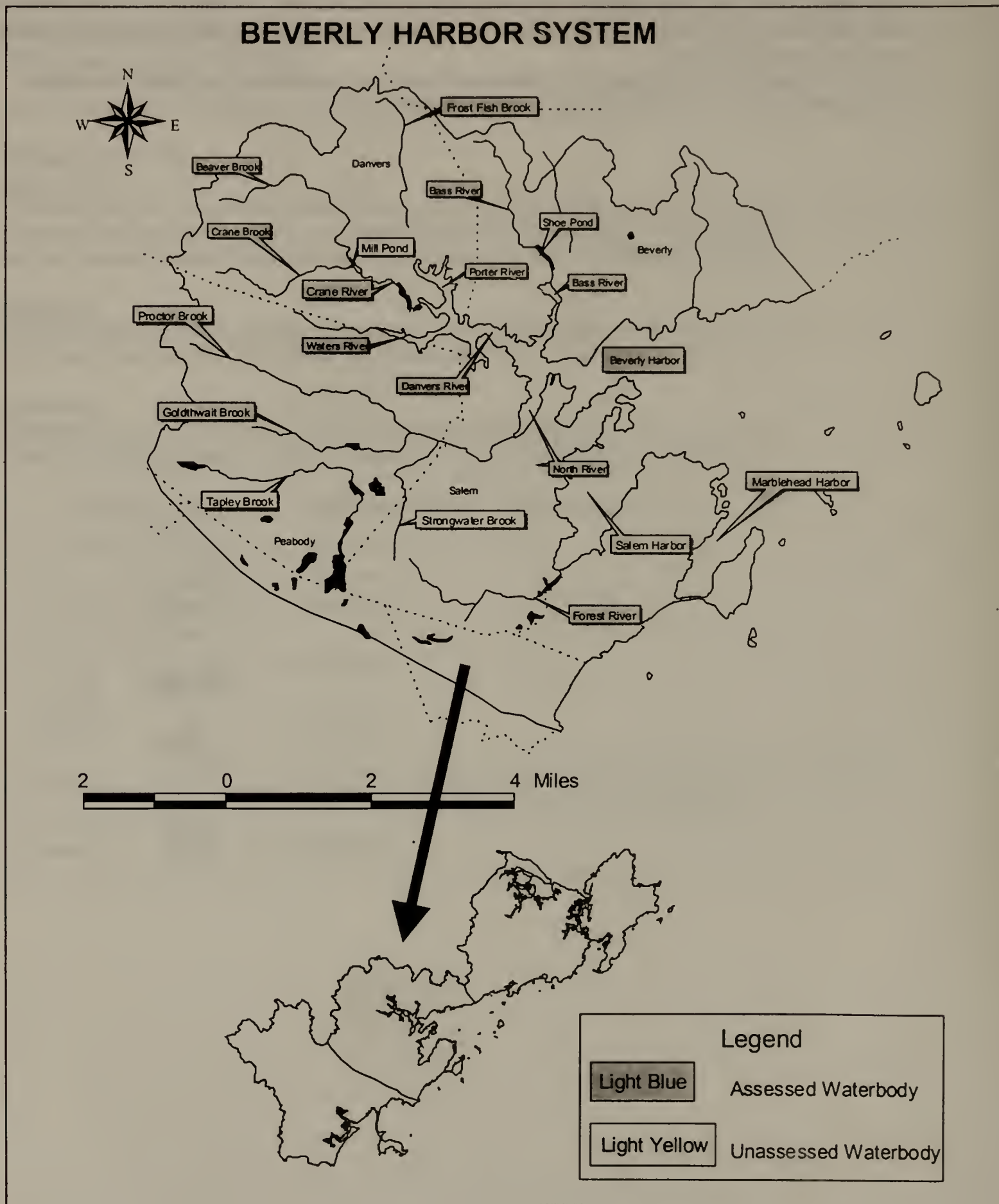
Designated Uses		Status: Manchester Harbor MA93-19
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 0.29 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Manchester Harbor MA93-19)

- Evaluate the seine and trawl data in DMF's *Study of the Marine Resources of Salem Sound, 1997* (Chase 2000) for use in the assessment of the *Aquatic Life Use*. Request assistance from CZM and DMF with these analyses.
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.
- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).

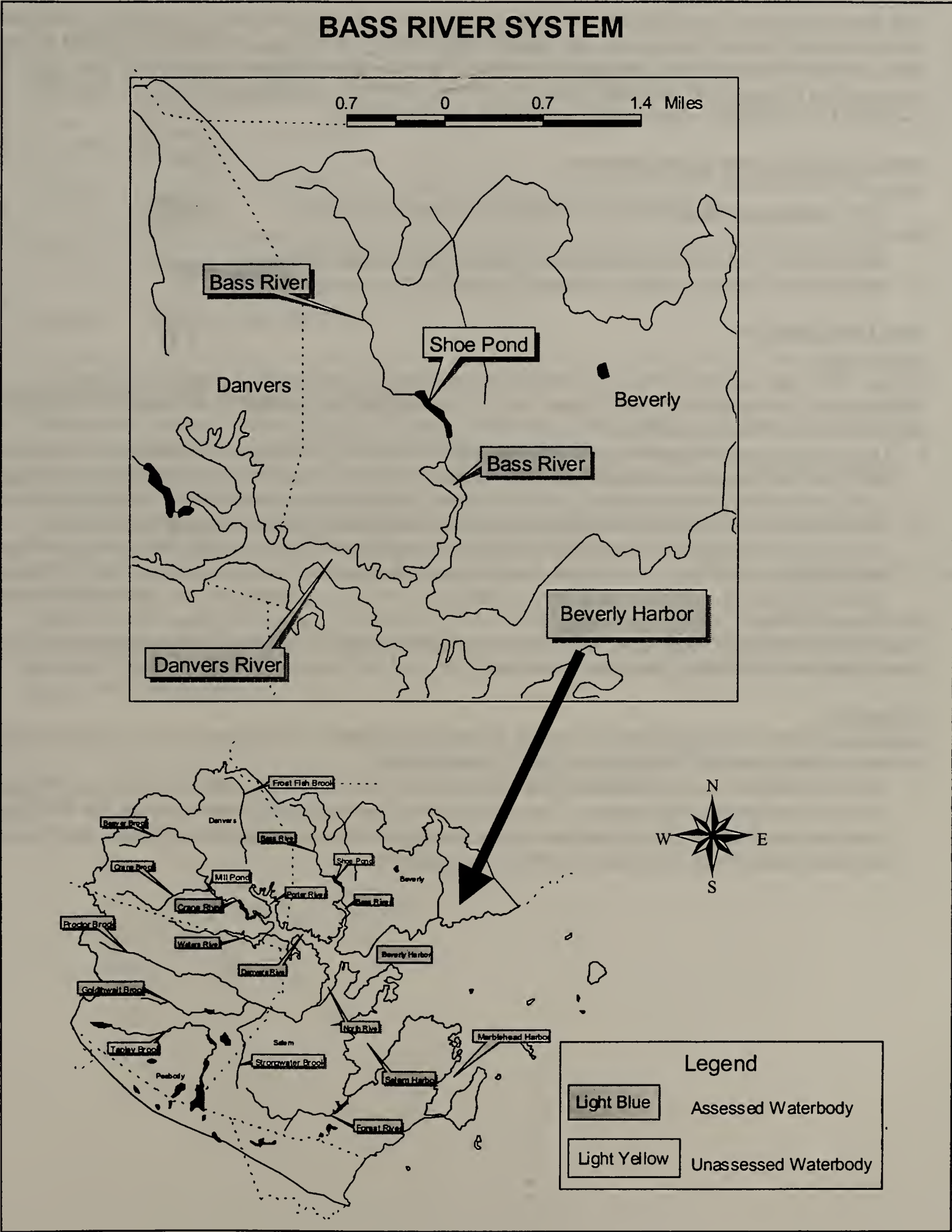
BEVERLY HARBOR SYSTEM

Beverly Harbor is bordered by the cities of Beverly to the north and Salem to the south. Beverly Harbor is approximately 0.78 mi² in area and similar in depth to Salem Harbor but receives a proportionately larger freshwater input from the combined flows of the Bass, Porter, Crane, Waters, and North rivers. All of these rivers flow into the Danvers River, which is tidal for its entire length, which discharge into Beverly Harbor. This river system drains highly urbanized sections of Salem, Peabody, Danvers and Beverly.



BASS RIVER SYSTEM

The Bass River is comprised of a freshwater and tidal reach, each of which is described in the following section.



BASS RIVER (SEGMENT MA93-07)

Location: Headwaters, west of Wenham Lake to the outlet of the lower basin of Shoe Pond north of Rt. 62, Beverly. Length/area: 2.9 river miles. Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

This stream drains south/southeast from the eastern border of the Beverly Municipal Airport under Route 128, past a golf course, through the two basins of Shoe Pond. The segment ends at the outlet the lower basin of Shoe Pond just north of Route 62 in Beverly after which the Bass River is tidal (Class SB). A review of the Chapter 21E file dated 14 April 1997 lists the following release tracking number sites: 3-0000611, 3-0000022, 3-0001456, 3-0000485, and 3-0000859.

WITHDRAWALS AND DISCHARGES

WMA:

1. WMA Withdrawal Registration # 31803001 for Emhart Industries.

NPDES:

1. MAR00A057 Varian Ion Implant System, general stormwater permit.
2. MAR00B436 Varian Ion Implant System, general stormwater permit.

USE ASSESSMENT

Aquatic Life

During 1997 DMF sampled the Bass River on seven occasions as part of *A Study of the Marine Resources of Salem Sound, 1997* (Chase 2000). One station was located on the Bass River at the spillway of upper Shoe Pond Dam.

- Dissolved oxygen concentrations ranged between 7.7 and 12.8 mg/L with supersaturation occurring on four of the seven sampling events (no samples collected pre-dawn). Although elevated in part by water movement from the spillway, high dissolved oxygen/supersaturation may be result from possible nutrient inputs. The synoptic lake survey of Shoe Pond identified it as a eutrophic waterbody.
- Temperature readings were all within the SWQS for a Class B, Warm Water Fishery. The instream pH ranged from 6.8 to 8.1 and raises some concern due to the increased toxicity of ammonia at pH levels close to 8.0. The ammonia concentrations, however, were relatively low as were the phosphate concentrations.

The results of the DMF water chemistry indicate no exceedences of the standards in this reach of the Bass River thus supporting the *Aquatic Life Use*.

Recreation

Additionally, DMF collected bacteria samples at the same location on the Bass River as part of *A Study of the Marine Resources of Salem Sound, 1997* (Chase 2000).

- Bacteria samples were collected on five occasions in 1997 with three collected during the *Primary Contact Recreational Use* season. The results of the bacteria testing were all below the SWQS and therefore the *Primary* and *Secondary Contact Recreational* uses are supported in the reach between the outlet upper Shoe Pond and the end of the segment.

SUMMARY

The *Aquatic Life Use* is assessed as supporting from the outlet of upper Shoe Pond to the end of the segment, based on water chemistry data collected by DMF. A synoptic lake survey was conducted on Shoe Pond and is incorporated in the Lakes Assessment Section of this report. The recreational uses are supported for 0.3 miles because of low fecal coliform bacteria densities.

Designated Uses

Status: Bass River MA93-07

Aquatic Life		NOT ASSESSED. The upper 2.6 miles of this segment are not assessed at this time. SUPPORT. The lower 0.3 miles of this segment support this use.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED. The upper 2.6 miles of this segment are not assessed at this time. SUPPORT. The lower 0.3 miles of this segment support this use.
Secondary Contact		NOT ASSESSED. The upper 2.6 miles of this segment are not assessed at this time. SUPPORT. The lower 0.3 miles of this segment support this use.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Bass River MA93-07)

- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).
- Perform additional monitoring of instream dissolved oxygen, pre- and -post dawn to characterize diurnal oxygen fluctuations.
- Review DMF's draft *A Study of the Marine Resources of Salem Sound, 1997* recommendations for future monitoring efforts in the Salem Sound subwatershed (Chase 2000).
- Verify the receiving waters of Varian Ion Implant System, general stormwater permit (MAR00A057 and MAR00B436).
- Determine the quantity of water withdrawn by WMA Withdrawal Registration # 31803001 for Emhart Industries and establish if this water withdrawal impacts the flow regime of this brook. Conduct a review of the for Emhart Industries WMA registration to minimize water withdrawals via water conservation measures.

BASS RIVER (SEGMENT MA93-08)

Location: Outlet of Shoe Pond north of Route 62, Beverly, to confluence with Danvers River, Beverly.
Length/area: 0.1 mi². Classification: Class SB.

SEGMENT DESCRIPTION

This segment drains a majority of the southwest portion of Beverly. The Bass River subwatershed is highly urbanized with industrial practices in close proximity to the river. The estimated 0.10 mi² area is classified as a SB waterbody.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MAG250520 Varian Associates, Inc. is authorized to discharge non-contact cooling water (city water supply) into an unnamed tributary of the Bass River. According to the company, outfall #001 discharges an average monthly flow of 0.00004MGD outfall #002 discharges 0.00009 MGD. The companies records indicate that outfall #001 the maximum discharge in 1997 and 1998 was 0.01 and 0.0008 MGD, respectively, whereas at outfall #002 the maximum discharge in 1997 and 1998 was 0.009 and 0.00004, respectively (Coker 1999).
2. MAS000013 Varian Associates, Inc. has submitted an application for an individual stormwater permit.

USE ASSESSMENT

Aquatic Life

Water quality sampling conducted by DEP in this system was limited to one survey date downstream of the Route 62 bridge at station BR01 (Appendix B, Figure B2). These data are presented in Appendix B, Tables B2-4 of this assessment report.

- Stream discharge was 10 cfs on the one sampling event.
- The dissolved oxygen level met the SWQS (12.2 mg/L and 96% saturation) although the measurement was not pre-dawn and therefore is not representative of worse-case conditions. The conductivity and chloride measurements (1,887 μ S/cm and 580 mg/L respectively) were indicative of estuarine conditions.

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that in area N17.0 (includes the Bass River) shellfishing is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

Recreation

DEP collected one fecal coliform bacteria sample under during wet weather conditions (4,000 cfu/100 mL) at the same location (Appendix B, Table B5) as water quality data.

SUMMARY

Due to limited water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as non-support for a 0.10 mi² area due to DMF a prohibition.

Designated Uses		Status: Bass River (MA93-08)
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 0.10 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Bass River MA93-08)

- The Bass River Interceptor Project resulted in the elimination of the Bass River Overflow as of 13 June 1997. Conduct post-remediation monitoring to determine if the removal of the CSOs has improved water quality in regards to fecal coliform bacteria levels.
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.
- Conduct further fecal monitoring during wet and dry weather conditions to establish the extent of the elevated levels and investigate possible sources (i.e., illicit sewer connections, CSOs, failing septic systems).
- Review DMF's draft *Study of the Marine Resources of Salem Sound, 1997* recommendations for future monitoring efforts in the Salem Sound subwatershed (Chase 2000).

DMF did not monitor the Bass River for smelt spawning because passage into the freshwater zone was blocked by a cooling pond for the former United Shoe Factory (Chase 1993). However, the factory is no longer operational and new development is proposed for the property.

- Although no documentation of a former anadromous fish run was found, the habitat in the upper and lower basins of Shoe Pond offers potential for alewife. Consideration should be given to restoring the natural tidal flow and removing obstructions to anadromous fish passage. The establishment of a smelt run in the Bass River and an alewife run up into Shoe Pond should be evaluated as a long-term management goal for the Danvers River System (Chase 1993).
- Identify whether or new development has occurred and its effects if any, on the potential anadromous fish run.

FROST FISH BROOK (SEGMENT MA93-36)

Location: Headwaters, Danvers to confluence with Porter River, Danvers. Length/area: 1.3 river miles.
Classification: Class B.

SEGMENT DESCRIPTION

The Porter River has one freshwater tributary (Frost Fish Brook). Headwaters of Frost Fish Brook are south of Putnamville Reservoir in Danvers. This Class B waterbody, flows in a southerly direction from just west of Princeton Street to its confluence with the Porter River in Danvers at the Route 62 bridge. A review of the Chapter 21E file dated 14 April 1997 lists the following release tracking number site: 3-1820.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0034819 – Thermadyne Wingersheek Building.

USE ASSESSMENT

Aquatic Life

DMF completed (1988-1990) a smelt spawning habitat monitoring program in the Porter River system, which documented smelt spawning in Frost Fish Brook. DMF documented smelt spawning habitat in the brook in a reach approximately 90m upstream of Route 62. Unlike other smelt spawning habitat monitored in this program (Chase 1993), the upstream extent of egg deposition was not limited by physical obstructions. Collectively, the habitat available for smelt spawning in Frost Fish Brook, is approximately 750 m². Nutrient loading and sedimentation were noted as being of concern for the smelt spawning habitat in this system.

Water quality sampling was conducted on seven occasions by DEP DWM at PR01 and on one occasion at FF01 (Appendix B, Figure B2). These data are presented in Appendix B, Tables B3 and B4 of this assessment report.

- Instream dissolved oxygen levels ranged between 7.8 and 14.0 mg/L and 70 to 101% saturation, although the measurements were made mid-day and do not represent worse-case conditions (pre-dawn).
- Nutrient levels were elevated—total phosphorus concentrations ranged between 0.01 and 0.14 mg/L and ammonia nitrogen between <0.02 and 1.4 mg/L.

Discharge of Frost Fish Brook (Route 62, Danvers) was measured by USGS on the surveys conducted from June through October 1997 and DEP personnel for the November 1997 through March 1998 surveys (Socolow *et al.* 1998 and Appendix B, Table B2). Discharge was lowest in October (0.17 cfs) and highest in March 1998 (9 cfs). Discharge was very low during all DEP surveys conducted between June and November 1997. Discharge in Frost Fish Brook at Cabot Road in Danvers was 4.8 cfs on 23 March 1998.

DEP conducted qualitative biological monitoring in this segment in July 1997 (Appendix C). Species richness in the sampling reach of Frost Fish Brook was good. The RBP II results were compared to the regional reference station (Saugus River downstream from Elm Street, Saugus) and moderate impairment was noted. Due to differences in drainage area between the reference station and this segment, the moderately impaired ranking of FF01 is not considered indicative of aquatic life impairment.

Overall the *Aquatic Life Use* for Frost Fish Brook is assessed as support for its entire length based on high water quality (DO) and biological survey results.

Recreation

DEP collected fecal coliform bacteria data at the same locations as water quality parameters were collected (FF01 and PR01). Fecal coliform bacteria levels were high four of the seven survey dates ranging between <20 and 4,000 cfu/100 mL resulting in assessing both *Primary* and *Secondary Contact Recreational* uses as impaired (non-support and partial support, respectively).

Aesthetics

DEP DWM habitat surveys indicate no impairment to the *Aesthetics Use* (Appendix C).

SUMMARY

Overall DEP survey data supports the *Aquatic Life* and *Aesthetics* uses. Elevated fecal coliform bacteria impair both the *Primary* and *Secondary Contact Recreational* uses (non and partial support respectively).

Designated Uses		Status: Frost Fish Brook (MA93-36)
Aquatic Life		SUPPORT. The entire 1.3 mile length of this segment is evaluated as supporting this use.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 1.3 mile length of this segment is evaluated as not supporting this use because of elevated levels of fecal coliform bacteria.
Secondary Contact		PARTIAL SUPPORT. The entire 1.3 mile length of this segment is evaluated as partially supporting this use because of elevated levels of fecal coliform bacteria.
Aesthetics		SUPPORT. The entire 1.3 mile length of this segment is evaluated as supporting this use.

RECOMMENDATIONS (FROST FISH BROOK MA93-36)

- Conduct further monitoring (fecal during wet and dry weather, and nutrient) to establish the extent of the elevated levels and investigate possible sources (i.e., illicit sewer connections, CSOs, failing septic systems).
- DMF (Chase 1993) recommendations for this segment include: stream flow quantification; nutrient sampling and substrate composition analyses. Additional recommendations were made to reduce sediment loadings by construction of new stormwater drains.
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.
- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).

PORTER RIVER (SEGMENT MA93-04)

Location: Confluence with Frost Fish Brook to the confluence with Danvers River, Danvers.

Length/area: 0.1 mi². Classification: Class SB.

SEGMENT DESCRIPTION

The Porter River Estuary, a Class SB waterbody, is located between the Route 62 Bridge in Danvers and its confluence with the Danvers River Estuary.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0100501 South Essex Sewage District. Their CSO outfall #002 which formally discharged from the River Street bypass and gate overflow weir into the Porter River was eliminated 8 December 1997.

USE ASSESSMENT

Aquatic Life

During 1997 DMF sampled the Porter River on 18 occasions as part of *A Study of the Marine Resources of Salem Sound, 1997* (Chase 2000). The DMF sampled the Porter River upstream of the Route 62 bridge in Danvers.

- Dissolved oxygen concentrations ranged between 7.4 and 13.0 mg/L. Supersaturation occurring on five of the 18 sampling events (no samples collected pre-dawn). Temperature readings were all below 29.4 °C.
- The instream pH ranged from 6.7 to 7.4 on the 16 sample dates. The ammonia concentrations were relatively low. Turbidity ranged between 2.0 and 28.1 NTU (13 measurements). The two elevated turbidity measurements occurred during February and March of 1997.

As part of DMF's *Study of the Marine Resources of Salem Sound, 1997*, beach seining was conducted in the Porter River (Sandy Beach) on multiple occasions from January-December (Chase 2000). The Sandy Beach seining finfish population was dominated by *Menidia menidia* (Atlantic silverside) and *Clupea harengus* (Atlantic herring).

Although there is some evidence of possible eutrophication, the water quality parameters (i.e., DO, pH, T) were within the SWQS thus supporting the *Aquatic Life Use*.

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that area N17.0, which includes the Porter River, is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

Recreation

During 1997 DMF sampled the Porter River on 11 occasions upstream of the Route 62 bridge in Danvers for fecal coliform bacteria as part of *A Study of the Marine Resources of Salem Sound, 1997* (Chase 2000). Eight samples were collected during the *Primary Contact Recreation* season. Bacteria counts during the primary recreation season ranged from 347 to >2400 cfu/100mL. Two measurements were collected during known "dry" weather conditions (25 June and 9 September 1997) both of which were >400 cfu/100 mL as were over 80% of all bacteria samples. Based on these data, the *Primary* and *Secondary Contact Recreational* uses are assessed as non-support.

Aesthetics

DEP DWM field personnel noted that sedimentation and floc covered the substrate, in the vicinity of a storm drain outfall (next to the CSO outfall). Algal blooms were observed and water quality visually appeared degraded. Increased turbidity was also observed during wet weather conditions (Beskenis 1999). Aesthetics between the Route 62 bridge and the Route 128 bridge was impaired (non-support).

SUMMARY

The *Aquatic Life Use* is supported in this segment based on the available water quality data (i.e., high DO, low NH_4). Both the *Primary* and *Secondary Contact Recreational* uses are assessed as non-support in the Porter River based on elevated fecal coliform bacteria levels. Field observations identified objectionable deposits thus impairing the *Aesthetics Use* (non-support) for the 0.02 mi^2 area between Route 62 and Route 128.

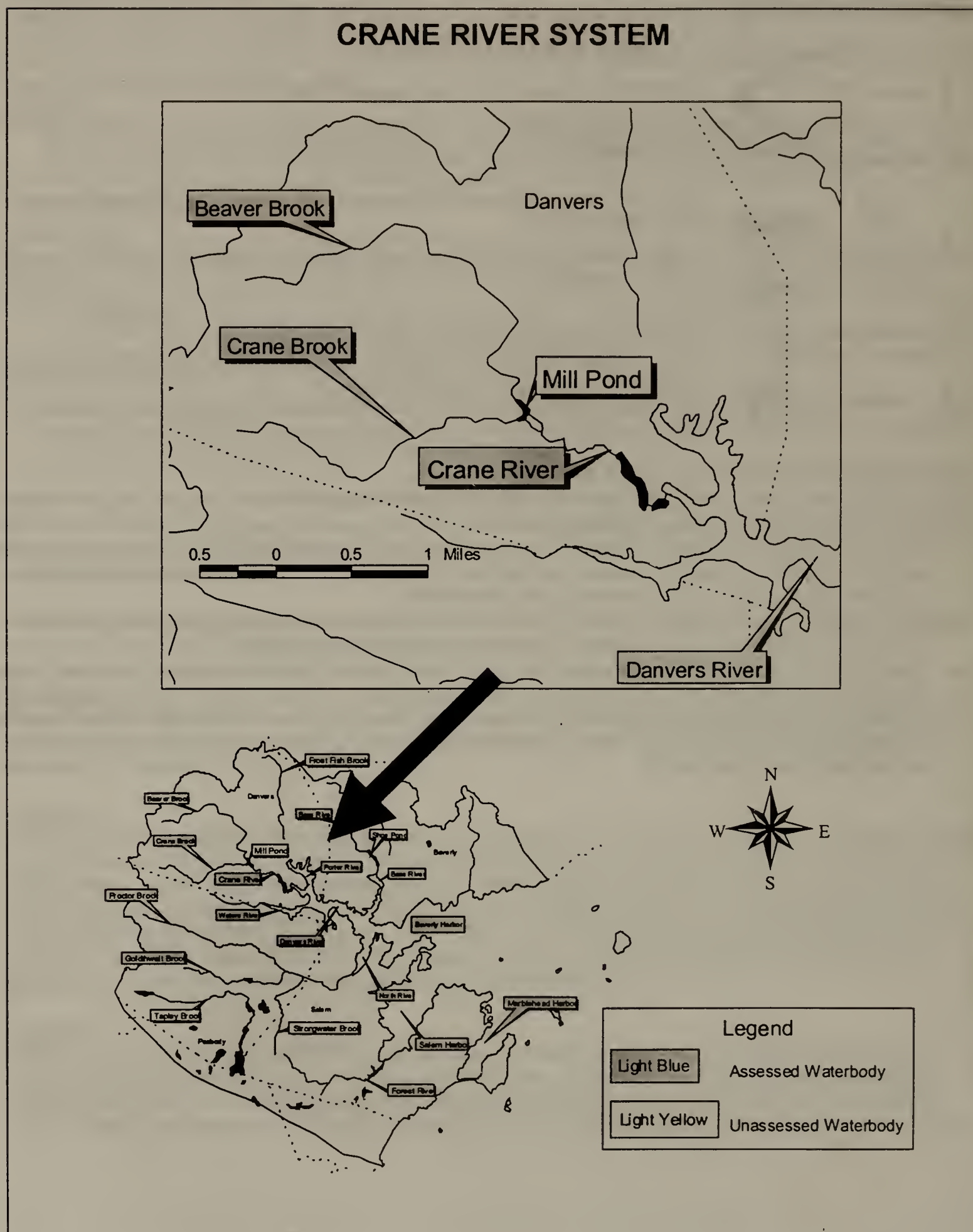
Designated Uses		Status: Porter River (MA93-04)
Aquatic Life		SUPPORT. The entire 0.10 mi^2 area supports this use.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 0.10 mi^2 area does not support this use due to elevated fecal coliform bacteria levels.
Secondary Contact		NON-SUPPORT. The entire 0.10 mi^2 area does not support this use due to elevated fecal coliform bacteria levels..
Shellfishing		NON-SUPPORT. The entire 0.10 mi^2 area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NON-SUPPORT. The 0.02 mi^2 area between routes 62 and 128 was impaired (non-support) due to sedimentation, algal blooms and turbidity. NOT ASSESSED. The remaining 0.08 mi^2 area (the lower Porter River) is not assessed for this use.

RECOMMENDATIONS (Porter River MA93-04)

- The CSO was eliminated on 8 December 1997. Identify if the aesthetic issues (sedimentation and floc) were reduced/eliminated by this removal.
- The combination of elevated DO/nutrients, algal blooms and elevated turbidity raises some concerns as to the impacts of elevated nutrients on the Porter River. Identify possible sources of elevated nutrients and turbidity and implement appropriate BMPs.
- Review DMF's draft *A Study of the Marine Resources of Salem Sound, 1997* recommendations for future monitoring efforts in the Salem Sound subwatershed (Chase 2000).
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.

CRANE RIVER SYSTEM

The Crane River System is comprised of two freshwater streams that flow into Mill Pond in Danvers; Beaver Brook and Crane Brook. The Crane River flows from the outlet of Mill Pond to its confluence with the Danvers River. Assessments follow for all segments in the Crane River subwatershed.



BEAVER BROOK (SEGMENT MA93-37)

Location: Headwaters, Danvers to confluence with Crane River, Danvers. Length/area: 3.5 river miles.
Classification: Class B.

SEGMENT DESCRIPTION

Beaver Brook originates west of Dayton Street in Danvers and flows in an easterly direction under the Newburyport Turnpike (Route 1) and Route 95. Beaver Brook passes through a small wetland and then under Route 62 before turning in a southeasterly direction and flows through Danvers town center to the inlet of Mill Pond in Danvers.

WITHDRAWALS AND DISCHARGES

None known.

USE ASSESSMENT

Aquatic Life

Water quality sampling in Beaver Brook was conducted on three occasions (June, July and September 1997) by DEP DWM at one station located upstream of Holten Street in Danvers (CR03). These data are presented in Appendix B, Tables B3 and B4 of this assessment report.

- Instream dissolved oxygen levels ranged from 4.8 to 9.8 mg/L and 51 to 110% saturation. It should be noted, however that all measurements were made mid-day and do not represent worse-case conditions (pre-dawn).
- Conductivity measurements were elevated for a freshwater system; this is most likely the result of urban runoff. Instream ammonia-nitrogen levels ranged between 0.03 and 0.05 mg/L while total phosphorus levels were between 0.04 and 0.06 mg/L.

Based on the DEP DWM survey information the *Aquatic Life Use* is evaluated as partial support due to slightly low levels of oxygen saturation instream during mid-day and concerns for lower levels under worse-case (pre-dawn) hours.

Recreation

Bacteria sampling in Beaver Brook was also conducted on three occasions (June, July and September 1997) by DEP DWM at one station (CR03). These data are presented in Appendix B, Table B5 of this assessment report.

- Fecal coliform bacteria levels in Beaver Brook were above the SWQS for the *Primary Contact Recreational Use* ranging from 280 to 540 cfu/100 mL.

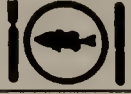
The *Primary Contact Recreational Use* is evaluated as non-support due to elevated levels of fecal coliform bacteria, however the *Secondary Contact Recreational Use* is evaluated as support.

Aesthetics

Stream flow measurements were made by DEP DWM in 1997 and ranged between 0.10 and 0.33 cfs (Appendix B, Table B2). When water levels were low, trash and broken glass were observed in Beaver Brook at CRO3. Downstream of the sampling station, the sediments were too thick to walk through. The *Aesthetic Use* was impaired in this localized area (Beskenis 1999). Conditions upstream of this area are unknown; therefore, the *Aesthetic Use* is not assessed.

SUMMARY

The *Aquatic Life Use* is assessed as partial support based on low DO. Fecal coliform bacteria levels were above the DEP DWM guidance for *Primary Contact Recreational Use* (non-support) whereas the *Secondary Contact Recreational Use* is supported.

Designated Uses		Status: Beaver Brook (MA93-37)
Aquatic Life		PARTIAL SUPPORT. The entire 3.5 mile length of this segment is evaluated as partial support for this use because of marginal levels of dissolved oxygen instream.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 3.5 mile length of this segment is evaluated as non-support for this use due to elevated fecal coliform bacteria levels.
Secondary Contact		SUPPORT. The entire 3.5 mile length of this segment is evaluated as supporting this use.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Beaver Brook MA93-37)

- Perform additional monitoring of instream dissolved oxygen, pre- and -post dawn to characterize diurnal oxygen fluctuations and to establish the extent of the problem.
- Fecal coliform monitoring should be conducted during wet and dry weather conditions to establish the extent of the elevated levels. Investigate possible sources of elevated bacteria (i.e., illicit sewer connections, CSOs, failing septic systems).
- Conduct an inventory of stormwater discharges to identify possible sources of contamination. These discharges may cause elevated specific conductance, increased sedimentation, increased bacteria and nutrient loading.
- Work with North Coastal Watershed Team to request community assistance in the removal of trash and debris from the brook near Holten Street in Danvers.

CRANE BROOK (SEGMENT MA93-02)

Location: Headwaters, Danvers to inlet of Mill Pond, Danvers. Length/area: 2.3 river miles. Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

Crane Brook flows from its headwaters west of the Newburyport Turnpike (Route 1) in Danvers in an easterly direction under the Route 1 and Route 95, runs parallel and then crosses Route 114 heading northeast. The brook flows northeast and into Mill Pond in Danvers.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0003859 GTE Sylvania, Inc., Sylvan Street Plant, Danvers is authorized to discharge via outfalls #001 0.334 MGD and #002 0.06 MGD of non-contact cooling water to an "unnamed tributary of Mill Pond" (Crane Brook), Danvers.

USE ASSESSMENT

Aquatic Life

Water quality sampling in Crane Brook was conducted by DEP DWM at two stations: CR04 located south of Route 114 in Danvers and CR02 located downstream of Pine Street in Danvers (Appendix B, Figure B2). The complete data sets are presented in Appendix B, Tables B3 and B4 of this assessment report.

- Instream dissolved oxygen ranged between 5.4 and 12.5 mg/L (55 to 92% saturation) at the upstream station (CR04). All measurements from the downstream station (CR02) were above the SWQS for a Class B Warm Water Fishery. It should be noted, however that all measurements were made mid-day and do not represent worse-case (pre-dawn) conditions.
- Conductivity measurements were elevated for a freshwater system and were highest at the upstream sampling station (CR04). Instream hardness and alkalinity measurements were generally the highest of those taken in the North Coastal Watershed.
- Instream ammonia-nitrogen levels were higher in Crane Brook at the upstream sampling station near Route 114 (ranging between 0.5 to 1.7 mg/L) than at the downstream station (0.03 to 0.18 mg/L). Total phosphorus concentrations were similar at both stations with concentrations between 0.02 and 0.05 mg/L.

Streamflow in Crane Brook was measured by DEP DWM on three occasions in 1997 at Pine Street in Danvers (Appendix B, Table B2). On each date, the discharge was less than 1.0 cfs. Similar flows were measured in Crane Brook at station CR04 (near Route 114) in July and September 1997. The highest stream flow (3.33 cfs) was measured on 23 March 1998 at CR04.

Based on the DEP DWM survey information the *Aquatic Life Use* is evaluated as partial support due to slightly low levels of oxygen saturation during mid-day and concerns for lower levels under worse-case (pre-dawn) hours.

Recreation

DEP DWM also sampled for fecal coliform bacteria in Crane Brook at stations CR02 and CR04 on three occasions. The bacteria levels at station CR04 ranged between 100 and 900 cfu/100 mL with the elevated level occurring during dry weather conditions. The downstream station, CR02, fecal coliform bacteria levels ranged between 80 and 280 cfu/100 mL.

Based on these data, the *Primary Contact Recreational Use* is evaluated as non-support for the entire length of this segment. Although fecal coliform bacteria levels met the DEP DWM guidance for the *Secondary Contact Recreational Use*, this use is assessed as non-support for the lower 0.4 miles because of the degraded aesthetic quality. The upper 1.9 mile reach supports the *Secondary Contact Recreational Use*.

Aesthetics

DEP DWM field personnel identified no objectionable aesthetic conditions upstream of Route 114. Therefore the *Aesthetics Use* is supported for the upper 1.2 miles of Crane Brook (DEP 1998d). Between Route 114 and Pine Street, the *Aesthetics Use* is not evaluated. At station CR02 (downstream) the

water column of Crane Brook appeared gray/turbid on several occasions and the streambed was covered with algae. Therefore the stream reach from Pine Street to the inlet of Mill Pond (0.4 miles) does not support either the *Recreational* or *Aesthetics* uses. Broken glass, trash and debris were also observed and degraded the aesthetic quality.

SUMMARY

The *Aquatic Life Use* is impaired (partial support) for the entire length of Crane Brook due to low dissolved oxygen. Elevated levels of fecal coliform bacteria impair (non-support) the *Primary Contact Recreational Use* for the entire length of this segment. The upper 1.2 mile reach of this segment of Crane Brook supports the *Aesthetics Use*. Turbidity and algae impair (non-support) both the *Secondary Contact Recreational* and *Aesthetics* uses in the lower 0.4 miles of Crane Brook.

Designated Uses		Status: Crane Brook (MA93-02)
Aquatic Life		PARTIAL SUPPORT. The entire 2.3 mile length of this segment is evaluated as partial support for this use because of marginal levels of dissolved oxygen instream.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 2.3 mile length of this segment is evaluated as non-support for this use due to elevated fecal coliform bacteria levels.
Secondary Contact		SUPPORT. The upper 1.9 mile length of this segment is evaluated as supporting this use, NON-SUPPORT. The lower 0.4 mile reach does not support this use because of algae.
Aesthetics		SUPPORT. The upper 1.2 mile length of this segment is evaluated as supporting this use. NOT ASSESSED. The middle 0.7 mile reach is not assessed. NON-SUPPORT. The lower 0.4 mile reach does not support the use because of instream turbidity/gray water and algae.

RECOMMENDATIONS (Crane Brook MA93-02)

- Perform additional monitoring of instream dissolved oxygen, pre and post dawn to characterize diurnal oxygen fluctuations and to establish the extent of the problem.
- Fecal coliform monitoring should be conducted during wet and dry weather conditions to establish the extent of the elevated levels. Investigate possible sources of elevated bacteria (i.e., illicit sewer connections, CSOs, failing septic systems).
- Investigate sources of turbidity downstream of Route 114. Conduct monitoring to evaluate the extent of the turbidity.
- Work with North Coastal Watershed Team to request community assistance in the removal of trash/debris from the lower portions of Crane Brook.

CRANE RIVER (SEGMENT MA93-38)

Location: Outlet Mill Pond, Danvers to outlet of the pump house sluiceway, Danvers. Length/area: 0.3 river miles. Classification: Class B.

SEGMENT DESCRIPTION

The Crane River, a Class B waterbody, flows from the outlet of Mill Pond in a generally southeasterly direction to the outlet of a pump house sluiceway at Purchase Street in Danvers.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0030091 – Riverside Condominiums, Danvers. 21 E hazardous waste site (#3-12423) discharge permit.

USE ASSESSMENT

Aquatic Life

The Crane River does not currently support a smelt run, according to DMF. Although the Crane River does not currently support a smelt run, according to DMF it does possess great potential for restoration (Chase 1993).

Water quality sampling in this segment of the Crane River was conducted by DEP DWM just upstream of Ash Street in Danvers (CR01) on seven occasions between 30 June 1997 and 23 March 1998 (Appendix B, Figure B2). The complete data sets are presented in Appendix B, Tables B3 and B4 of this assessment report.

- Instream dissolved oxygen concentrations were between 6.0 and 12.9 mg/L and 70 to 92% saturation, all meeting the state water quality standards (SWQS) for a Class B waterbody. However, it must be kept in mind that sampling was not conducted pre-dawn and therefore the data collected do not represent worse-case conditions.
- Nutrient levels were slightly elevated—total phosphorus concentrations ranged between 0.02 and 0.08 mg/L and ammonia nitrogen between 0.05 and 0.32 mg/L. Nitrate nitrogen concentrations did not exceed 1.0 mg/L.

During 1997, DMF sampled the Crane River (upstream of Ash Street, Danvers) on 18 occasions as part of their *Study of the Marine Resources of Salem Sound, 1997* (Chase 2000).

- Dissolved oxygen concentrations ranged between 5.4 and 13.0 mg/L with supersaturation occurring only once and one measurement below 60% (59.1 %saturation). However, no DO samples were collected during worse-case conditions (pre-dawn).
- The instream pH ranged from 6.8 to 7.6 (16 sampling events). Turbidity ranged between 5.0 and 49.8 NTU (13 sampling events).
- Ammonia concentrations ranged between 0.010 and 0.394 mg/L.

Streamflow in the Crane River was measured by USGS on four occasions between 30 June and 21 October 1997 at Ash Street in Danvers and by DEP DWM on the three subsequent surveys (Socolow *et al.* and Appendix B, Table B2). Discharge was lowest in October 1997 (0.64 cfs) and highest in March 1998 (18.5 cfs).

Benthic macroinvertebrate monitoring was conducted in July 1997 by DEP DWM in a reach just upstream of Ash Street in Danvers (CR01). The sampling reach appeared to offer very good habitat. The riparian zone on both sides of the stream was mostly wooded. There was evidence of bank erosion and the substrates were covered with fine particulate organic matter within the sampling reach. The RBP II analysis identified this reach of the Crane River as not impaired (Appendix C).

The DEP DWM and DMF water quality results indicate only minor excursions from the SWQS and the DEP DWM biological analysis identified no impairment. Based on this information, the *Aquatic Life Use* is supported in this segment of the Crane River.

Recreation

DEP DWM collected fecal coliform bacteria samples from the Crane River just upstream of Ash Street in Danvers at station CR01 (Appendix B, Table B5).

- The fecal coliform bacteria counts ranged from 80 to 2,400 cfu/100 mL although only one of the seven samples exceeded the *Primary Contact Recreational Use* guidance (See Use Assessment Methodology).

During 1997, DMF collected fecal coliform bacteria samples from the Crane River (upstream of Ash Street, Danvers) on 11 occasions as part of their *Study of the Marine Resources of Salem Sound, 1997* (Chase 2000).

- During the primary contact season fecal coliform densities ranged from 110 to 900 cfu/100mL with 50% of the samples above 400 cfu/100 mL. Of the 11 sampling events two samples were collected during weather conditions known to be representative of dry conditions. These results were 243 and 532 cfu/100 mL (Chase 2000).

Based on DEP DWM and DMF data, the *Primary Contact Recreational* use is assessed as non-support. While the *Secondary Contact Recreational Use* is also evaluated as non-support, the assessment is based primarily on the poor aesthetic quality of this segment.

Aesthetics

DEP DWM field observations identified the aesthetic quality to be poor on multiple occasions (Nuzzo 1998). The water column appeared gray, turbid and "opaque" (white plume) during the summer months in 1997. These conditions impair (non-support) the *Aesthetics Use* for this segment of the Crane River.

SUMMARY

The *Aquatic Life Use* is supported for this segment of the Crane River based on water quality data and high habitat quality for benthic invertebrates. *Primary* and *Secondary Contact Recreation* are impaired due to, in part, elevated levels of fecal coliform bacteria. Additionally, the aesthetics are degraded in the entire segment impairing the *Aesthetics*, and *Secondary Contact Recreational* uses.

Designated Uses		Status: Crane River (MA93-38)
Aquatic Life		SUPPORT. The entire 0.3 mile length of this segment is evaluated as supporting this use.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 0.3 mile length of this segment is evaluated as not supporting this use because of fecal coliform bacteria and the observations of gray water/turbidity.
Secondary Contact		NON-SUPPORT. The entire 0.3 mile length of this segment is evaluated as not supporting this use because of fecal coliform bacteria and the observations of gray water/turbidity.
Aesthetics		NON-SUPPORT. The entire 0.3 mile length of this segment is evaluated as not supporting this use due to observations of gray water and a milky white plume observed instream in the summer of 1997.

RECOMMENDATIONS (Crane River MA93-38)

- In 1997 Danvers DPW completed a sluiceway to secure passage of smelt. Upon completion of this passage, DMF proposed a three-year study to closely monitor egg hatching, larval movement and returning adults in the Crane River as a control stream for a smelt egg stocking program. Investigate effectiveness of fish passage remediation.
- River herring restoration efforts should also be considered for the Crane River.
- Attempts should be made to identify the sources of the instream turbidity, fecal coliform bacteria and elevated nutrients. Determine if the elevated nutrients are a seasonal condition or if corrective actions resulted in the lower nutrient levels beginning in the spring of 1997.
- Review DMF's draft *Study of the Marine Resources of Salem Sound, 1997* recommendations for future monitoring efforts in the Salem Sound subwatershed (Chase 2000).
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.

CRANE RIVER (SEGMENT MA93-41)

Location: Outlet pump house sluiceway, Danvers to confluence with Danvers River, Danvers.
Length/area: 0.08 mi². Classification: Class SA.

SEGMENT DESCRIPTION

From the outlet of the pump house sluiceway on Purchase Street in Danvers, the Crane River, a Class SA waterbody, flows in a generally easterly direction to its confluence with the Danvers River. A review of the Chapter 21E file dated 14 April 1997 lists one site: 3-12423.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0036331 – Crane River West Condominiums Stormwater Discharge, Danvers.

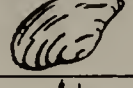
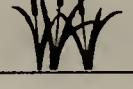
USE ASSESSMENT

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that area N17.0, which includes the Waters River, is prohibited (Churchill 1999). Based on this information, the *Shellfishing Use* for this segment is assessed as non-support.

SUMMARY

Due to the lack of current water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as non-support for a 0.08 mi² area due to a DMF prohibition.

Designated Uses		Status: Crane River (MA93-41)
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 0.08 mi ² area of this segment does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Crane River MA93-41)

- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).
- Review DMF's draft *Study of the Marine Resources of Salem Sound, 1997* recommendations for future monitoring efforts in the Salem Sound subwatershed (Chase 2000).
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.

WATERS RIVER (SEGMENT MA93-01)

Location: Headwaters north of Route 114, Peabody to confluence with the Danvers River, Danvers.
Length/area: 0.08 mi². Classification: Class SB.

SEGMENT DESCRIPTION

The Waters River tidal estuary (Class SB) flows from its headwaters near the Peabody/Danvers line upstream of Mt Pleasant Drive in Peabody to its confluence with the Danvers River in Danvers. The Waters River Estuary is constricted at two locations (by a railroad crossing near the middle of the segment and by the Route 35 Bridge on its eastern shore separating it from the Danvers River Estuary. There are currently two 21 E sites in the Waters River subwatershed. MA0036293 OSRAM Sylvania is listed as a Chapter 21E class A2 RAO R3-2830 site. MA0036129 ITW is listed as a Tier II, Phase III Ch. 21E site.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0025411 GTE Sylvania Incorporated which closed on 14 October 1992.
2. MA00024732 Northeast Petroleum Corporation –Pocahantas Fuel Company, Inc. has three outfalls 001, 002 and 003 which discharge into the Waters River. The permit (formerly White Fuel Corp.) expired 9 November 1983. No reapplication is in the file.

USE ASSESSMENT

Aquatic Life

Water quality sampling was conducted by DEP DWM at one station in the Waters River (WA01), located downstream of Sylvan Street, Peabody (Appendix B, Figure B2). Attempts to sample further upstream in the Waters River in July 1997 were unsuccessful due to a lack of sufficient stream flow. The complete water quality data sets are presented in Appendix B, Tables B3 and B4 of this assessment report.

- Instream dissolved oxygen levels all met SWQS and ranged between 8.8 and 11.6 mg/L and 74 to 98% saturation. The measurements were made mid-day and do not represent worse-case conditions (pre-dawn).
- Nutrient levels were highest in the March samples (0.13 mg/L ammonia-nitrogen and 0.08 mg/L of total phosphorus) collected during a snowmelt as described below. The total suspended solid (17 mg/L) and turbidity (37 NTU) levels were also slightly elevated in the March samples.

During 1997 DMF sampled the Waters River (off Endicott Street, Danvers) on 14 occasions as part of their *Study of the Marine Resources of Salem Sound, 1997* (Chase 2000). These samples were collected in the freshwater portion of the Waters River downstream of the confluence of two small tributaries in close proximity to DEP DWM's sampling location.

- Dissolved oxygen concentrations ranged between 8.1 and 11.6 mg/L with supersaturation occurring on three of the 14 sampling events (no samples collected pre-dawn).
- Temperature readings were all within the SWQS for a Class SB, estuary. The instream pH ranged from 6.8 to 7.6. Nutrient sampling indicated relatively low ammonia and phosphate concentrations.

Streamflow of the Waters River at downstream of Sylvan Street, Peabody was measured by USGS and DEP DWM on the four surveys conducted from June through October 1997 and by DEP from November 1997 through March 1998 (Socolow *et al.* and Appendix B, Table B2). Discharge increased from 1.86 cfs to 4.22 cfs in seven hours on 23 March 1997, not a result of tidal increase, but rather the effect of snowmelt and runoff. Discharge was lowest in November (0.16 cfs) and highest in March 1998, although no measurements between June and January exceeded 1.0 cfs.

Benthic macroinvertebrate monitoring was conducted by DEP in July 1997 in a reach just downstream of Sylvan Street in Peabody/Danvers (WA01). The aquatic habitat in the freshwater portion of this river was poor, with little flow at the time of sampling. Only qualitative sampling was conducted because of the low flow conditions, and six different families of macroinvertebrates were found (Appendix C).

The results of the DEP DWM and DMF water chemistry analyses indicate no exceedences of the SWQS in this reach of the Waters River and thus support the *Aquatic Life Use*.

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that area N17.0 that includes the Waters River is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

Recreation

Bacteria sampling was conducted by DEP DWM at one station in the Waters River (WA01), located downstream of Sylvan Street, Peabody. The complete data set is presented in Appendix B, Table B5. Fecal coliform bacteria levels ranged between 200 and 3,200 cfu/100 mL.

DMF also sampled bacteria at their water quality station on the Waters River as part of their *Study of the Marine Resources of Salem Sound, 1997* (Chase 2000). Samples were collected on 11 occasions and 63% of the samples exceeded 400 cfu/100mL. Of the 11 samples collected two were collected during known dry weather conditions. The fecal coliform bacteria levels in these samples ranged from 347 to 900 cfu/100mL.

Bacterial levels were above the SWQS in more than 25% of the samples collected, including samples collected during dry weather. Therefore both the *Primary* and *Secondary Contact Recreational* uses are not supported.

Aesthetics

The DEP DWM habitat survey of the benthic macroinvertebrate monitoring effort identified high levels of trash/debris and heavy sediment deposition (Appendix C). As a result of these objectionable deposits, trash and debris the *Aesthetics Use* is impaired (non-support).

SUMMARY

The results of the DEP 1997/1998 survey and the DMF 1997 indicated no impairment (support) of *Aquatic Life Use*. Both the *Primary* and *Secondary Contact Recreational* uses are evaluated as non-support due to elevated fecal coliform bacteria levels. This segment does not support the *Shellfishing Use* due to the current DMF status (prohibited). *Aesthetics* is also non-support due to objectionable sediment deposition, trash and debris.

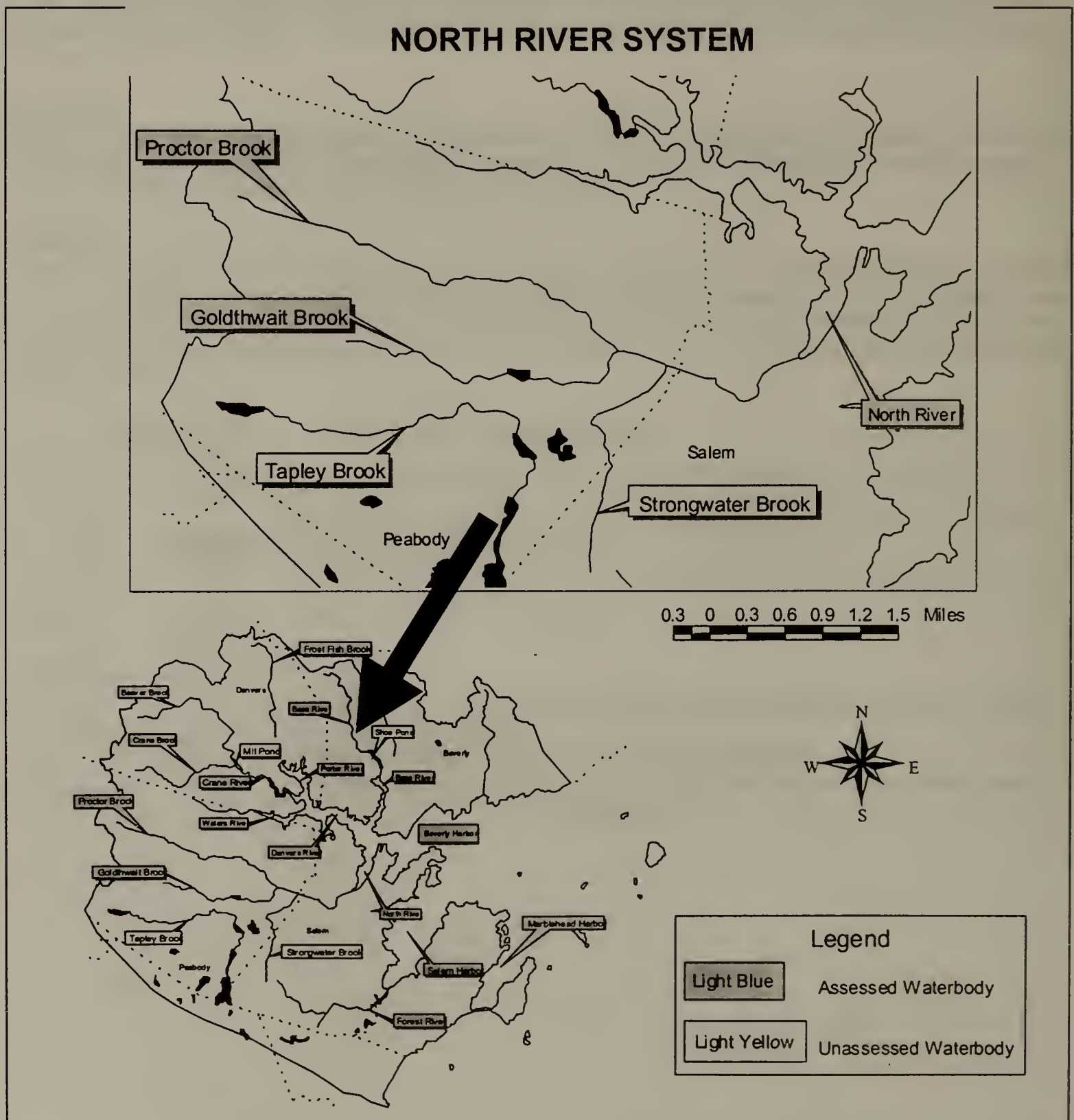
Designated Uses		Status: Waters River (MA93-01)
Aquatic Life		SUPPORT. This use is evaluated as support for the entire 0.08 mi ² area of this segment.
Primary Contact		NON-SUPPORT. The entire 0.08 mi ² area of this segment does not support this use due to elevated fecal coliform bacteria levels.
Secondary Contact		NON-SUPPORT. The entire 0.08 mi ² area of this segment does not support this use due to elevated fecal coliform bacteria levels.
Fish Consumption		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 0.08 mi ² area of this segment does not support this use due to current DMF status (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NON-SUPPORT. The entire 0.08 mi ² area of this segment does not support this use due to trash, debris, and objectionable deposits in-stream.

RECOMMENDATIONS (Waters River MA93-01)

- Identify and remediate sources of fecal coliform bacteria. Conduct sampling during wet and dry weather conditions to establish the extent of the problem.
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.
- Implement storm water management practices to reduce runoff of debris, trash, silt and sand from the parking lots and storm drains adjacent to the Waters River.
- Review DMF's draft *Study of the Marine Resources of Salem Sound, 1997* recommendations for future monitoring efforts in the Salem Sound subwatershed (Chase 2000).
- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).
- Conduct site visit and determine the status of NPDES #MA00024732 Northeast Petroleum Corp. If the company is still actively discharging, reassess discharge quantity/quality and reissue permit.

NORTH RIVER SYSTEM

The North River receives flow from one freshwater tributary named Proctor Brook. Proctor Brook is fed by two named streams, Goldthwait Brook and Strongwater Brook. Goldthwait Brook receives flow from one named tributary, Tapley Brook. Review of historical water quality data from the North River system (Goldthwait and Proctor Brooks and the North River revealed that pathogens impaired the *Primary* and *Secondary Contact Recreational uses* while low levels of dissolved oxygen and high concentrations of ammonia-nitrogen impaired the *Aquatic Life Use*. Ammonia-nitrogen concentrations on 18 and 19 August 1987 at four stations (two each on Goldthwait and Proctor Brooks) ranged between 0.99 and 3.2 mg/L) and averaged 2.4 mg/L (Duerring 1989). Other pollution problems (sediment contamination) were also problematic. Assessments follow for Goldthwait and Proctor Brooks and the North River.



GOLDTHWAIT BROOK (SEGMENT MA93-05)

Location: Outlet Cedar Pond, Peabody to confluence with Proctor Brook, Peabody.

Length/Area: 3.3 river miles. Classification: Class B, Warm Water Fishery.

SEGMENT DESCRIPTION

Goldthwait Brook is a Class B, Warm Water Fishery. It flows in a generally easterly direction from the outlet of Cedar Pond, through an industrialized area and into a small impoundment (Craigs Pond). The brook continues to head east, receives flow from an unnamed tributary on the north side and drains into a wetland area. Goldthwait Brook is joined by Tapley Brook from the south side and it flows past the Eastman Gelatine Corporation facility as it continues east towards its confluence with Proctor Brook in the center of Peabody. As it passes through downtown Peabody the brook is contained in concrete channels or runs underground. As of 15 April 1997, a review of the Chapter 21E sites (hazardous waste sites) indicate multiple locations where minor spillage of petroleum or hazardous waste were reported.

WITHDRAWALS AND DISCHARGES

WMA:

1. Eastman Gelatine Corporation is registered (# 31822902) to withdraw 2.74 MGD from 12 wells and one surface water – Sidney's Pond. The facility is engaged in the manufacturing of photographic gelatin. The facility's water is supplied primarily from a wellfield located adjacent to the receiving water although city water is also used at the facility. The water is used in the gelatin process and for barometric condenser cooling and electric generators. They are also permitted (#9P21822902) to withdraw an additional 2.26 MGD from a combination of their registered sources and a new well, for a total withdrawal volume of 5.0 MGD
2. Peabody Water Department is registered 31822903 to withdraw 1.9 MGD of surface-water from Spring Pond (in the Tapley Brook subwatershed). Since Peabody diverts water from the Ipswich River Basin into Spring Pond, the actual volume of water withdrawn from the Tapley Brook subwatershed is undetermined.

NPDES:

1. MA0003956 Eastman Gelatine Corporation discharges non-contact cooling water (0.5 MGD average monthly flow) and storm water runoff from outfall 001 and storm water runoff from 18 other outfalls into Goldthwait Brook. The facility is engaged in the manufacturing of photographic gelatin. The wastewater generated from the gelatin process is discharged to the Peabody sewer system which in turn is part of the South Essex Sewage District.
2. MAG640006 Coolidge Avenue Water Treatment Facility is authorized to discharge filter backwash water to Spring Pond and emergency overflows to Tapley Brook.
3. MA0028584 Stahl Finishing, Peabody 21 E hazardous wastesite (3-0413) discharge permit.
4. MA0028215 Permuthane Inc, Peabody. The permit has expired and outfall pipes #007 and #008 are regulated under Stahl USA general permit MA0035467.

USE ASSESSMENT

Aquatic Life

Eastman Gelatine Corporation has conducted instream and effluent (outfall #001) toxicity testing as required by their NPDES permit since April 1995 (Dallaire 1998). Acute toxicity tests, using *Ceriodaphnia dubia*, have been run on grab samples collected from Goldthwait Brook as well as samples collected from outfall #001. Their samples are collected both upstream and downstream of all of their discharges under both dry and wet weather conditions. The results of these tests are summarized below (Dallaire 1998):

Upstream: Upstream of the Eastman discharge, no acute instream toxicity to *C. dubia* was detected in the 15 sampling events (April 1995 to November 1998) representing both dry and wet weather conditions. Survival of *C. dubia* exposed to Goldthwait Brook water has ranged between 95 and 100%.

Effluent: Outfall #001 has exhibited acute toxicity under both dry and wet conditions (LC50s between 17.8 and 70.7% effluent in the seven definitive acute toxicity tests submitted). Survival in the non-contact cooling water samples (dry weather sampling events) has ranged between 0 and 25%. Survival in the combined non-contact cooling water/stormwater sampling was poor in earlier samples (0%) but much better (95 – 100%) in the two most recent test results (1997 and 1998).

Downstream: Instream toxicity in Goldthwait Brook, downstream of all of the Eastman Gelatine Corporation discharges, has been detected in some samples and not others. Survival of *C. dubia* exposed to Goldthwait Brook samples collected under dry weather conditions ranged between 50 and 100%. Two out of seven test results (sampling period February 1996 to November 1998) indicate acute toxicity in Goldthwait Brook. The toxicity test results from the wet weather sampling indicated severe instream toxicity (survival of organisms 0 – 4%) in the two earliest tests (April and May 1995) but no instream toxicity in the six wet-weather samples tested since then (survival ranges from 90 – 100% in samples collected from April 1996 to July 1998).

The Eastman Gelatine Corporation was also required to conduct a pH study in Goldthwait Brook to determine the effect of their permitted discharges (non-contact cooling water and stormwater) on the pH of the brook. The results of their monitoring (Harding 1989) are inconclusive and merit further investigation.

Water quality sampling was conducted by DEP DWM at one station in Goldthwait Brook, GB01 located downstream of the Eastman Gelatine Corporation discharges near Foster Street in Peabody (Appendix B, Figure B2). Samples were collected in November 1997, January, and March 1998. No samples were collected in October due to the lack of flow in the brook on the day of the survey. The complete data sets are presented in Appendix B, Tables B3 and B4 of this assessment report.

- Instream dissolved oxygen levels were below SWQS in November 1997 at 4.2 mg/L and 35% saturation but all met SWQS on both the January and March 1998 survey dates.
- Nutrient levels were relatively low—total phosphorus concentrations were 0.02 mg/L and ammonia nitrogen between 0.28 and 0.49 mg/L. Nitrate-nitrogen concentrations did not exceed 1.1 mg/L. Other water quality variables measured were also within the expected concentrations.

DEP DWM personnel measured discharge of Goldthwait Brook (Foster Street, Peabody) on 18 November 1997, 21 January and 23 March 1998. Discharge was 0.03 cfs in November, and estimated to be 5.29 cfs in January and 19.1 cfs in March (Appendix B, Table B2).

DEP DWM benthic macroinvertebrate reconnaissance in July 1997 determined that the aquatic habitat in Goldthwait Brook just downstream from First Avenue, Peabody, could serve as a reference station (Appendix C). On 29 July 1997, however, the portion upstream from First Avenue resembled a hypereutrophic lake with dense growths of rooted aquatic vegetation, attached filaments and floating mats of algae, and soft bottom sediments. Downstream the streambed was completely dry, presumably because of a blockage under the bridge. These conditions impair the *Aquatic Life Use* in the upper section of Goldthwait Brook. Nearly the entire length of Goldthwait Brook had very poor macroinvertebrate habitat and was not suitable for application of the RBP methodologies. The *Aquatic Life Use* is further impaired by the channelization of Goldthwait Brook as it passes through downtown Peabody.

The *Aquatic Life Use* is assessed as partial support for the upstream 2.4 miles of this due to flow modification/habitat quality limitations. This use is not supported for the lower 0.9 miles of this segment based on evidence of instream toxicity as well as the habitat quality limitations.

Recreation

DEP DWM collected fecal coliform bacteria samples at one station in Goldthwait Brook on two occasions, January and March 1998 (Appendix B, Table B5). These samples did not exceed the SWSQ for a Class B, Warm Water Fishery (200 cfu/100 mL) however; the dataset was too limited to assess the *Primary Contact Use*.

Aesthetics

In July of 1997 DEP DWM field crew noted that the water upstream from Foster Street was stagnant and putrid-looking. Additionally, the presence of dense growths of rooted aquatic vegetation, attached filaments and floating mats of algae was also noted (Appendix C). The *Aesthetics Use* is therefore assessed as partial support.

SUMMARY

Instream toxicity, habitat modification and flow reduction impair (partial support) the *Aquatic Life Use* for the upper 2.4 miles of Goldthwait Brook. The lower 0.9 miles of this brook are non-supported for the *Aquatic Life Use* based on evidence of instream toxicity as well as evidence of habitat limitations. The *Secondary Contact Recreational* and *Aesthetics* uses are assessed as non-support due dense aquatic vegetation and algal mats/filaments.

Designated Uses		Status: Goldthwait Brook (MA93-05)
Aquatic Life		PARTIAL SUPPORT. The upstream 2.4 miles of this segment is evaluated as partially supporting this use due to flow modification/habitat quality limitations. NON-SUPPORT. The lower 0.9 miles of this segment does not support the <i>Aquatic Life Use</i> based on evidence of instream toxicity as well as the habitat quality limitations.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		PARTIAL SUPPORT. The entire 3.3 mile length of this segment is assessed as partially supporting this use due to the aesthetic quality limitations described below.
Aesthetics		PARTIAL SUPPORT. The entire 3.3 mile length of this segment is assessed as partially supporting this use because of the presence of dense growths of rooted aquatic vegetation, attached filaments and floating mats of algae.

RECOMMENDATIONS (GOLDTHWAIT BROOK MA93-05)

- An inflow/outflow analysis is recommended for this segment to determine the source of the apparent low flow/habitat limitations for aquatic life.
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.
- Efforts should be made to minimize water withdrawals (see specific recommendations under Eastman Gelatine Corporation) in this subwatershed in an effort to maximize streamflows and to reduce the frequency of "dry streambeds" in Goldthwait Brook.
- Perform additional monitoring of instream dissolved oxygen, pre- and -post dawn to characterize diurnal oxygen fluctuations and to establish the extent of the low dissolved oxygen.
- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).
- Determine if all discharges from Permuthane Inc, Peabody permit (MA0028215) are currently regulated under Stahl USA general permit, MA0035467.
- Since Peabody diverts water from the Ipswich River Basin into Spring Pond, the actual volume of water withdrawn from the Tapley Brook subwatershed is undetermined. An accurate flow gauge should be installed to quantify this water withdrawal.

RECOMMENDATIONS Continued (GOLDTHWAIT BROOK MA93-05)

Eastman Gelatine Company

WMA:

- Eastman Gelatine Corporation submitted a letter to DEP (dated 16 March 1999) which provided information to the DEP to complete the five-year review of their WMA Permit 9P318229.02. The letter (Gordon 1999) provided DEP with information regarding water conservation measures, stating that there has been a 29% decrease in water withdrawal rates between 1993 and 1998 (3.14 MGD to 2.2 MGD, respectively). The letter also indicated that their projected usage during the next five years would propel demand to approximately 4 MGD for the following reasons:
 1. Co-Generation Project requiring approximately 0.8 MGD,
 2. process for the Future Technology requiring approximately 0.5 MGD,
 3. increased future production requiring 0.1 MGD,
 4. gelatin recovery project requiring approximately 0.011 MGD, and
 5. providing the City of Peabody water for a new municipal golf course requiring approximately 0.2 MGD.
- Given the occurrence of "dry streambeds" in Goldthwait Brook under their current operating conditions, requests for increased water withdrawals in the Goldthwait Brook subwatershed merits careful consideration, even though these projected water-use estimates would be within the company's 5.0 MGD permitted water withdrawal volume.
- Require a detailed accounting of Eastman Gelatine's water use and discharge operations (including a schematic of water supply/wastewater discharge and location). Review this current and projected budget in relation to their increase withdrawal on water quantity in Goldthwait Brook.

NPDES:

- Require Eastman Gelatine Corporation to eliminate toxicity from outfall #001.
- Monitor the effectiveness of Eastman Gelatine Company's remediation efforts in reducing instream toxicity in Goldthwait Brook.

PROCTOR BROOK (SEGMENT MA93-39)

Location: Outlet small pond north of Downing Road, Peabody to Goodhue Street Bridge, Salem.
Length/area: 2.9 river miles. Classification: Class B.

SEGMENT DESCRIPTION

This segment of Proctor Brook, a Class B waterbody, begins in a wetland south of the Boston and Maine Railroad, just north of Downing Road in Peabody. Proctor Brook flows in a generally easterly direction, and crosses under Route 128. The brook then crosses under the railroad three times prior to its journey through downtown Peabody. The brook is culverted under part of the town and reappears just north of the library. Both Goldthwait and Strongwater brooks join Proctor Brook in Peabody before it flows into Salem. This segment ends at the Goodhue Street Bridge (approximate boundary +/- 200m of the salt-water wedge).

WITHDRAWALS AND DISCHARGES

WMA:

1. The Peabody Water Department is registered (#31822903) to withdraw 1.89 MGD. The public water supply identification numbers (3229000-01 and -02) for their wells suggest that both are located in the Ipswich River watershed. The Zone II of these wells (GIS April 1998 DEP Approved Zone II datalayer), however, extends into the headwater drainage area of Proctor Brook.
2. The Salem Country Club is registered (#31822901) to withdraw a total of 0.1 MGD from a tubular Well Field and an irrigation pond.

NPDES:

1. MA0023132 Peabody Municipal Light Plant is an old power generating plant (built in 1948) and used rarely according to a letter from the facility dated 1978. The company's 1980 permit authorized a discharge of overflow water from a cooling pond (estimated 0.005 MGD daily average, 0.01 MGD daily maximum), via outfall #001, into Proctor Brook near Warren Street in Peabody. The letter from the company also stated that the cooling pond water was treated with a product purchased from W.H. & L.D. Betz to prevent rust or corrosion in the pipes. The permit limited the discharge to no more than twice per year for no greater period than one day. A narrative statement in the permit limited temperature to "*No increase above that of the receiving body of water*".
2. MA0025372 Salem Oil & Grease Company, a manufacturer and importer of tanners oils, is authorized to discharge via outfall #001 0.0024 MGD of process equipment cooling water and air conditioner cooling water. Permit was issued December 1975. Chapter 21E r-3-2131 NFA (no further action)
3. MA0026794 Bayoil Co., Inc, a manufacturer of leather oil was authorized to discharge 0.013 MGD of non-contact cooling water drawn from an artesian well into a municipal (Peabody) storm drain. This discharge most likely goes into Proctor Brook. This permit was issued in 1978 and there was no reapplication in the permit file. Current status of facility is unknown.
4. MA0033723 Federal Express. Chapter 21E 3-2221

USE ASSESSMENT

Aquatic Life

DMF did not document any smelt spawning in Proctor Brook despite the presence of adequate physical habitat (adequate freshwater flow with no impediments to passage, and numerous shallow water riffles with gravel substrate) between Goodhue and Howley Streets in Peabody (Chase 1993). DMF stated that the potential spawning habitat in the North River system was clearly degraded due to chronic pollution inputs. Discoloration and oil sheens in the water were commonly observed. Dead American eels (*Anguilla rostrata*) and sea worms (*Nereis*) were also observed on several occasions during DMF surveys.

Water quality sampling was conducted by DEP DWM at one station in Proctor Brook; NR01 located just downstream of Howley Street in Peabody (Appendix B, Figure B2). These data are presented in Appendix B, Tables B3 and B4 of this assessment report.

- Instream dissolved oxygen concentrations were all above 7 mg/L and 71% saturation. The measurements were made mid-day and do not represent worse-case conditions.
- Temperatures in this segment of Proctor Brook ranged from 2.1 to 23.3 °C.
- Nutrient levels were elevated—total phosphorus concentrations ranged between 0.03 and 0.14 mg/L and ammonia nitrogen between 0.10 and 0.58 mg/L. Nitrate nitrogen concentrations did not exceed

1.7 mg/L. Instream conductivity measurements were highest in the winter months and probably reflect road-salting practices.

During 1997 DMF sampled Proctor Brook (identified as the North River, downstream face of Howley St. culvert) on 18 occasions as part of their *Study of the Marine Resources of Salem Sound, 1997* (Chase 2000).

- Dissolved oxygen concentrations ranged between 6.6 and 13.6 mg/L. Supersaturation occurred on one occasion. None of the samples were collected pre-dawn. Nutrient concentrations were elevated during the winter months of 1997. Ammonia concentrations ranged from 0.011 to 0.712 mg/L. Phosphate concentrations ranged from 0.004 to 0.274mg/L. The instream pH ranged from 6.9 to 7.4 SU.

Streamflow of Proctor Brook was measured by both the USGS and DEP in 1997 and 1998 (Socolow *et al.* 1998 and Appendix B, Table B2). Streamflow was lowest in October (0.44 cfs) and highest in March 1998 (39.5 cfs). During all surveys conducted between July and November 1997 stream discharge was very low.

DEP DWM conducted biological monitoring in Proctor Brook in July 1997 at one location (NR01 downstream of Howley Street) in Peabody (Appendix C). This sampling station was in a heavily industrialized section of Peabody and the instream habitat was relatively poor. Nonpoint source pollution from runoff, trash, and the bordering industrial uses (historical and current) impact the aquatic community at NR01. This site was clearly degraded with only one family, the amphipod Gammaridae, identified in the sub-sample. The RBP II analysis indicated severe impairment.

The *Aquatic Life Use* is not assessed in the upper 1.9 miles of this segment due to a lack of data. The *Aquatic Life Use* is non-support for the lower 1.0 mile reach (downstream from the confluence with Goldthwaite Brook) based on habitat quality limitations, nutrient enrichment, and the severely impaired benthic community.

Aesthetics

DEP DWM biological monitoring field crews identified multiple sources of nonpoint source pollution (runoff, trash, and the bordering industrial uses). These conditions degraded the *Aesthetics Use* in the lower 1.0 miles of Proctor Brook. This use is not assessed in the upper 1.9 miles.

Recreation

Fecal coliform bacteria sampling was conducted by DEP DWM at one station in Proctor Brook. Fecal coliform bacteria levels were high on all survey dates ranging between 640 and 50,000 cfu/100 mL (Appendix B, Table B5).

All fecal coliform samples (11) collected as part of DMF's draft *Study of the Marine Resources of Salem Sound, 1997* were above 900 fcu/100mL (Chase 2000). Samples collected during dry weather conditions had fecal coliform concentrations >2400 cfu/100mL.

Based on these data, both the *Primary and Secondary Contact Recreational Uses* are assessed as non-support in the lower 1.0 mile reach of this segment. Upstream of the confluence with Goldthwaite Brook, these uses are not assessed.

SUMMARY

Proctor Brook is impaired for all assessed uses downstream from the confluence with Goldthwait Brook (lower 1.0 miles). The macroinvertebrate community was impaired due to poor habitat, nutrient enrichment and nonpoint source pollution, therefore the *Aquatic Life Use* is assessed as non-support. The *Primary* and *Secondary Recreational* uses are also assessed as non-support due to elevated levels of fecal coliform bacteria. Nonpoint source pollution and degraded habitat render the *Aesthetics Use* as non-support for the lower 1.0 miles.

Designated Uses		Status: Proctor Brook (MA93-39)
Aquatic Life		NOT ASSESSED. The upper 1.9 miles of this segment are not assessed due to a lack of data. NON-SUPPORT. The lower 1.0 miles do not support the <i>Aquatic Life Use</i> as evidenced by habitat quality limitations, nutrient enrichment and an hyperdominated aquatic community.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED. The upper 1.9 mile length of this segment is not assessed. NON-SUPPORT. The lower 1.0 miles of the segment do not support this use because of elevated levels of fecal coliform bacteria.
Secondary Contact		NOT ASSESSED. The upper 1.9 mile length of this segment is not assessed. NON-SUPPORT. The lower 1.0 miles do not support due to elevated fecal coliform bacteria.
Aesthetics		NOT ASSESSED. The upper 1.9 mile length of this segment is not assessed. NON-SUPPORT. The aesthetic quality in the lower 1.0 miles of the segment is poor due to nonpoint source pollution runoff and degraded habitat from trash, debris and sedimentation.

RECOMMENDATIONS (Proctor Brook MA93-39)

- Review DMF's draft *Study of the Marine Resources of Salem Sound, 1997* recommendations for future monitoring efforts in the Salem Sound subwatershed (Chase 2000).
- Specific DMF recommendations related to the smelt spawning habitat monitoring program in the North River system included the following (Chase 1993):
 - Minimize nonpoint source pollution inputs to improve instream and riparian habitat quality as well as aesthetics. Work with the North Coastal Watershed Team to organize a river clean-up to remove large objects and discarded trash.
 - The North River system should be included as part of the long-term goal of anadromous fish restoration in the Danvers River System. Several thousand square meters of potential smelt spawning habitat would be made available if sedimentation and chronic pollution problems were remediated.
 - Quantify river flow, nutrient concentrations and substrate composition in Proctor Brook. Nutrient loading and sedimentation are a concern for the smelt spawning habitat in the North River system.
 - Appraise and upgrade stormwater catch basins with the best technology to trap sediments and pollutants. Pollutant sources without permits should also be investigated and brought into compliance.
- Investigate possible sources of elevated bacteria (i.e., illicit sewer connections, CSOs, failing septic systems) and remediate. Investigate possible sources of elevated nutrients (i.e., illicit sewer connections, CSOs, failing septic systems) and remediate.
- The status of the NPDES dischargers needs to be verified. Site visits should be conducted to determine if the facilities are still in operation. Flow schematics should also be provided (water source and volume as well as discharge location and volume). Effluent quality characterization information should also be acquired if the NPDES permits will be renewed. Compliance with new permit limits should be enforced.
- Sediment quality data from the 1987 and 1988 North Coastal Water Quality Surveys (Duerring 1989) indicated very high concentrations of heavy metals (Cr, Pb, and Zn) and polycyclic aromatic hydrocarbons (PAHs) in the sediments of the North River system. The impacts observed in the late 1980's may well be attributable to toxic contaminants present in the sediments. Although no recent sediment quality or toxicity data have been collected, future monitoring efforts should address this issue in addition to the nutrient enrichment and sedimentation problems in the North River watershed.

PROCTOR BROOK (SEGMENT MA93-40)

Location: Goodhue Street Bridge, Salem, to Route 114 culvert, Salem.
Length/area: 0.01 mi². Classification: Class SB.

SEGMENT DESCRIPTION

This segment of Proctor Brook, a Class SB waterbody, flows between the Goodhue Street and Route 114 Bridge/culvert in Salem. The brook then discharges into the North River estuary.

WITHDRAWALS AND DISCHARGES

None known.

USE ASSESSMENT

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that area N17.0, which includes the Waters River, is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

SUMMARY

Due to the lack of current water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as non-support for a 0.01 mi² area due to a DMF prohibition.

Designated Uses		Status: Proctor Brook (MA93-40)
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 0.01 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Proctor Brook MA93-40)

- Fecal coliform monitoring should be conducted during wet and dry weather conditions to establish if the upstream conditions (elevated bacteria levels) extend into this segment. If levels are elevated, investigate possible sources of elevated bacteria (i.e., illicit sewer connections, CSOs, failing septic systems) and remediate.
- Sediment quality data from the 1987 and 1988 North Coastal Water Quality Surveys (Duerring 1989) indicated very high concentrations of heavy metals (Cr, Pb, and Zn) and polycyclic aromatic hydrocarbons (PAHs) in the sediments of the North River system. Future monitoring efforts should address this issue in addition to the nutrient enrichment and sedimentation problems in the North River watershed.

NORTH RIVER (SEGMENT MA93-42)

Location: Downstream of Route 114 Bridge (Proctor Brook), Peabody to confluence with Danvers River, Salem. Length/area: 0.20 mi². Classification: Class SA.

SEGMENT DESCRIPTION

The North River estuary, a Class SA waterbody, lies between the Route 114 bridge/culvert in Peabody and confluence with the Danvers River. A review of the Chapter 21E file dated 14 April 1997 lists the following release tracking number sites: 3-0012927, 3-0012710, 3-0013814, 3-0010900, and 3-0011726.

WITHDRAWALS AND DISCHARGES

None known.

USE ASSESSMENT

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that their area (N17.0) in the North River is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* is assessed as non-support.

SUMMARY

Due to the lack of current water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as non-support for a 0.2 mi² area due to a DMF prohibition.

Designated Uses

Status: North River (MA93-42)

Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 0.2 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (North River MA93-42)

- Fecal coliform monitoring should be conducted during wet and dry weather conditions to establish if the upstream elevated bacteria levels extend into this segment. If levels are elevated, investigate possible sources of elevated bacteria (i.e., illicit sewer connections, CSOs, failing septic systems) and remediate.
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.
- Sediment quality data from the 1987 and 1988 North Coastal Water Quality Surveys (Duerring 1989) indicated very high concentrations of heavy metals (Cr, Pb, and Zn) and polycyclic aromatic hydrocarbons (PAHs) in the sediments of the North River system. Future monitoring efforts should address this issue in addition to the nutrient enrichment and sedimentation problems in the North River watershed.
- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).

DANVERS RIVER (SEGMENT MA93-09)

Location: Confluence of Porter, Crane, and Waters rivers, Danvers to mouth of Beverly Harbor.
Length/area: 0.50 mi². Classification: Class SB.

SEGMENT DESCRIPTION

The Danvers River Estuary, a Class SB water, is formed at the confluence of the Porter, Crane and Waters Rivers near Danversport. The river forms the corporate boundary between Danvers and Beverly and Salem near Fosters Point. The Bass River, draining a part of Beverly, and the North River, draining part of Salem, also flow into the Danvers River upstream of its confluence with Beverly Harbor (Route 1A bridge) in Beverly/Salem. The Danvers River Estuary is a relatively shallow estuary with a large intertidal area and a high flushing rate; approximately 70% of the total water volume is exchanged with each tide cycle. A review of the Chapter 21E file dated 14 April 1997 lists one release tracking number site: 3-2887.

WITHDRAWALS AND DISCHARGES

WMA:

1. The Kearwood Country Club is registered (#31825801) to withdraw 0.1 MGD from a groundwater source.

Vessel sewage pump-out facilities:

1. Danvers Yacht Club (River), Danvers.

USE ASSESSMENT

Aquatic Life

As part of DMF's *Study of the Marine Resources of Salem Sound, 1997*, beach seining (Obear Park) and bottom trawling (upper and lower Danvers River) were conducted in the Danvers River on multiple occasions from January-December (Chase 2000). Water chemistry parameters were collected in the upper and lower Danvers River.

- Results of beach seining at Obear Park indicated a finfish population dominated by *Menidia menidia* (Atlantic silverside) and *Fundulus* spp. (mummichog).
- *Pseudopleuronectes americanus* (winter flounder) and *Raja* spp. (skate) dominated the upper and lower Danvers River trawls.
- In the upper Danvers River, dissolved oxygen concentrations were very similar in the surface and bottom waters. DO ranged between 6.0 and 13.7 mg/L with supersaturation occurring 50% of the time (no samples collected pre-dawn). Temperature readings all met the SWQS for a Class SB, estuary. The instream pH ranged from 7.6 to 8.3 in both the surface and bottom waters.
- In the lower Danvers River, DO concentrations were very similar in the surface and bottom waters (range 7.0 - 11.9 mg/L) with supersaturation occurring approximately 40% of the time (no samples collected pre-dawn). Temperature readings all met the SWQS. The instream pH ranged from 7.7 to 8.1 in both the surface and bottom waters.

Based on these data (high DO) the *Aquatic Life Use* is assessed as support in the Danvers River.

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that their area (N17.0), which includes the Waters River, is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

SUMMARY

DMF's *Study of the Marine Resources of Salem Sound, 1997* (Chase 2000) identified no violations of the SWQS and therefore the *Aquatic Life Use* is supported in this segment. Shellfishing is assessed as non-support based the DMF shellfishing prohibition.

Designated Uses

Status: Danvers River (MA93-09)

Aquatic Life		SUPPORT. This use is supported for the entire 0.50 squares miles of the Danvers River.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 0.50 mi ² area does not support this use due to a DMF shellfishing prohibition. For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Danvers River MA93-09)

- DMF (Chase 1993) recommended the removal of all active CSOs discharging in the Danvers River. Additionally DMF recommended all new construction of stormwater drains that connect to the Danvers River system be regulated to prevent sediment entry to the waterways.
- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).
- Evaluate the seine and trawl data in the DMF report titled *A Study of the Marine Resources of Salem Sound, 1997* (Chase 2000) for use in the assessment of the *Aquatic Life Use*. Request assistance from CZM and DMF to develop standard methods for interpreting marine biological monitoring data as part of the *Aquatic Life Use* assessment.
- Conduct nutrient monitoring to identify if the DO supersaturation and elevated pH readings are related to point or nonpoint source pollution. If nutrients are elevated, establish an inventory of wastewater practices to track possible sources.
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.

BEVERLY HARBOR (SEGMENT MA93-20)

Location: East of Route 1A between Beverly/Salem to an imaginary line between Woodbury Point in Beverly southwest to Salem Neck in Salem. Length/area: 0.78 mi². Classification: Class SB.

SEGMENT DESCRIPTION

Beverly Harbor is located east of the Bridge Street bridge (Route 1A) between Beverly/Salem to an imaginary line between Woodbury Point in Beverly southwest to Salem Neck in Salem. A review of the Chapter 21E file dated 14 April 1997 lists the following release tracking number sites: 3-0003736, 3-0003909, and 3-0000831.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0100501 South Essex Sewage District has one CSO outfall #003, the Wilson Avenue bypass and overflow weir, which discharges into Beverly harbor. A 1997 letter to DEP and an inspection report identified this discharge as closed on 23 December 1996.

Vessel sewage pump-out facilities:

1. Ferryway Public Landing, Beverly.

USE ASSESSMENT

Aquatic Life

As part of DMF's *Study of the Marine Resources of Salem Sound*, 1997 beach seining was conducted in Beverly Harbor (Tuck's Point) on multiple occasions from January-December (Chase 2000). The Tuck's Point finfish population was dominated by *Brevoortia tyrannus* (Atlantic menhaden) and *Clupea harengus* (Atlantic herring).

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that their area (N17.0), which includes Beverly Harbor, is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

SUMMARY

Due to the lack of current water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as non-support for a 0.78 mi² area due to a DMF prohibition.

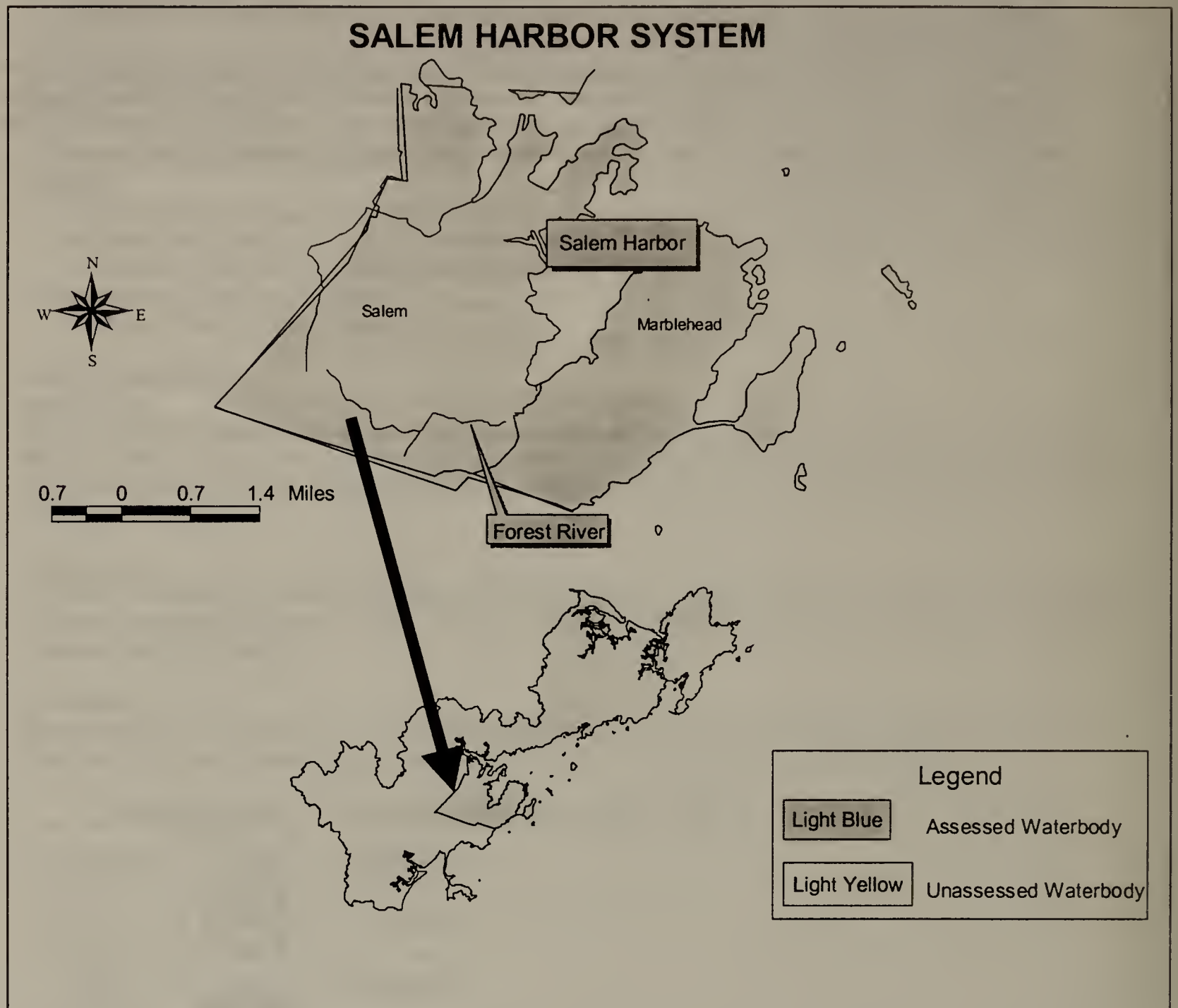
Designated Uses		Status: Beverly Harbor (MA93-20)
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 0.78 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Beverly Harbor MA93-20)

- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).
- Evaluate the seine and trawl data in the DMF draft report titled *A Study of the Marine Resources of Salem Sound, 1997* (Chase 2000) for use in the assessment of the *Aquatic Life Use*. Request assistance from CZM and DMF to develop standard methods for interpreting marine biological monitoring data as part of the *Aquatic Life Use* assessment.
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.

SALEM HARBOR SYSTEM

The Salem Harbor drainage area is comprised of the Forest River that discharges into Salem Harbor. Assessments for both of these waterbodies follow.



FOREST RIVER (SEGMENT MA93-10)

Location: Upstream of Loring Avenue, Salem to mouth of Salem Harbor, Salem/Marblehead.
Length/area: 0.05 mi². Classification: Class SB.

SEGMENT DESCRIPTION

This Class SB segment of the Forest River begins approximately one-half mile upstream of Loring Avenue in Salem. The river meanders in a generally easterly direction, under Loring Avenue and then heads northeast to its mouth at Salem Harbor, Salem/Marblehead. The mouth of the Forest River is known locally as the "Lead Mills". A lead mill was operated there for approximately 100 years beginning in 1826. Several junkyards and a closed landfill lie upstream in the freshwater drainage area.

WITHDRAWALS AND DISCHARGES

None known.

USE ASSESSMENT

Aquatic Life

DMF conducted a smelt spawning habitat monitoring program in the Forest River in 1989 and 1990 (Chase *et al.* 1994). They reported that a smelt run was not present in the Forest River during their surveys.

DEP DWM conducted water quality sampling, in the Forest River approximately 0.4 miles upstream of Loring Avenue (FR01), on two occasions (Appendix B, Figure B2). These data are presented in Appendix B, Tables B3 and B4 of this assessment report.

- Dissolved oxygen levels met standards on both survey dates. Measurements, however, were made in the afternoon and do not represent worst case (pre-dawn) conditions.
- Suspended solids were slightly elevated on one occasion (16mg/L).
- The instream temperature measured in June (27.2°C) was above the daily mean temperature standard for a Class SB waterbody, it was slightly below the daily maximum standard of 29.4°C. Results of other water quality variables were all within expected ranges and did not indicate water quality problems.

During 1997 DMF sampled Forest River (just upstream of DEP DWM station FR01) on six occasions as part of DMF's *Study of the Marine Resources of Salem Sound, 1997* (Chase 2000).

- Dissolved oxygen concentrations ranged between 7.3 and 11.6 mg/L (no samples collected pre-dawn). Temperature readings all met SWQS for a Class SB, estuary. The instream pH ranged from 7.0 to 7.5 SU.
- Nutrient concentrations in Forest River were not elevated in any of the four months that DMF sampled. Ammonia concentrations ranged from 0.004 to 0.092 mg/L and phosphate ranged from 0.001 to 0.020mg/L.

Both the USGS and DEP measured streamflow of the Forest River in 1997 and 1998 (Socolow *et al.* 1998 and Appendix B, Table B2). Discharge was low (0.09 cfs) in June 1997 but much higher in March (6.79 cfs).

Based on DEP DWM and DMF water quality data (Dissolved Oxygen, Temperature, etc.), the *Aquatic Life Use* is supported for Forest River.

Shellfishing

The DMF Shellfish Status Report of January 1999 does not specifically designate any areas in this segment as a shellfish growing area. However, DMF conducted a study on heavy metal concentrations in soft shell clams (*Mya arenaria*) and found average lead concentrations in Forest River samples to be 10 times greater than the average from other Salem Harbor locations and samples collected from Boston Harbor. This habitat has been closed by DMF to all forms of digging because of gross contamination (Chase *et al.* 1994). The *Shellfishing Use* is assessed as non-support.

Recreation

DEP DWM conducted fecal coliform bacteria sampling in the Forest River (FRO1) on two occasions. Fecal coliform bacteria counts were elevated during dry weather conditions in June 1997 (540 cfu/100 mL) and low (20 cfu/100 mL) in March (Appendix B, Table B5).

DMF conducted bacteria sampling on three occasions in 1997 just upstream of DEP DWM water quality station FR01. All three fecal coliform bacteria counts were well below 200 cfu/100mL. One sample was collected during a dry weather event and no samples were collected during wet weather (Chase 2000).

The *Primary Contact Recreational Use* is assessed as partial assessed due to one elevated fecal coliform bacteria sample out of the four samples (25%) collected during the primary recreation season. The *Secondary Contact Recreational Use* is supported based on these data.

Aesthetics

Chase and Roderick (1994) noted the encroachment of *Phragmites australis* in the stream channel. This invasive species subsequently reduces freshwater flows. This non-native wetland plant is considered a form of nuisance aquatic vegetation (see Use Assessment Methodology). These data are too old to assess the *Aesthetics Use*.

SUMMARY

Based on water quality data (Dissolved Oxygen, Temperature, etc.), the *Aquatic Life Use* is supported for Forest River. The *Primary Contact Recreational Use* is assessed as partial support due to elevated fecal coliform bacteria and the *Secondary Contact Recreational Use* is supported. The *Shellfishing Use* is assessed as non-support based on DMF's closure to all forms of digging.

Designated Uses		Status: Forest River (MA93-10)
Aquatic Life		SUPPORT. The entire 0.05 mi ² area of this segment is supported.
Fish Consumption		NOT ASSESSED.
Primary Contact		PARTIAL SUPPORT. The entire 0.05 mi ² area of this segment is partial support due to elevated fecal coliform bacteria.
Secondary Contact		SUPPORT. The entire 0.05 mi ² area of this segment supports this use.
Shellfishing		NON-SUPPORT. The entire 0.05 mi ² area of this segment are not supported due to DMF's closure to all forms of digging. For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Forest River MA93-10)

- No conclusive evidence of smelt spawning in the Forest River was found during the 1989 and 1990 sampling visits (Chase *et al.* 1994). Although it is possible that the Forest River once supported a smelt population, historical documentation is lacking. Coupled with the present encroachment of *Phragmites australis* in the stream channel and related reduction in freshwater flows, DMF recommended that the Forest River not be considered for a smelt restoration project.
- Chase *et al.* (1994) recommended that studies be conducted to quantify potential impacts of tide-gate operations on marsh vegetation and river substrate conditions (natural marsh vegetation changes to monospecific strands of *Phragmites australis*). Specifically they recommend 1) a time series of aerial photographs from the past few decades to potentially estimate the vegetation changes and 2) local authorities evaluate tide-gate operation alternatives that will allow natural conditions of tidal flooding to return. Updated data vegetative cover could be used to assess the *Aesthetics Use* in this segment.

RECOMMENDATIONS Continued (Forest River MA93-10)

- Additional fecal coliform monitoring should be conducted during wet and dry weather conditions to establish the extent of the elevated bacteria. Investigate possible sources of elevated bacteria (i.e., illicit sewer connections, CSOs, failing septic systems) and remediate.
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.

SALEM HARBOR (SEGMENT MA93-21)

Location: Marblehead/Salem. Length/area: 1.62 mi². Classification: Class SB.

SEGMENT DESCRIPTION

This is a Class SB estuary. For the purpose of this report, the harbor is defined as the waters inside of an imaginary line drawn across Winter Island, Salem to Naugus Head, Marblehead. Salem Harbor is the site of numerous Chapter 21E sites due to the release of petroleum and/or hazardous waste (printout dated 15 April 1997).

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0005096 USGenNE (formerly New England Power Salem Station) has several outfalls:
 - Outfall 001: 668.9 MGD of condenser cooling water, boiler blowdown, reboiler and evaporator blowdown, freshwater storage tank overflow, service water, boiler blowdown tanks, and stormwater runoff from the yard. Chlorine or hydantoin is authorized for biocide. Total Residual Oxidants should not exceed 0.1 mg/L (Simultaneous multi-unit application of biocide was permitted). The permit also stated that "at no time can the outfall exceed an absolute temperature of 93°F" and further stated that "at no time can temperature of this outfall exceed a 28°F rise over intake temperature". The permit also required that "a temperature differential between the point of discharge and the intake structure shall not change more than 12°F during any one-hour period from 1 April to 31 October nor shall the differential change more than 9°F between 1 November and 31 March during any one-hour period".
 - Outfall 006: 1.5 MGD average monthly/2.6 MGD maximum daily discharge of wastewater treatment service-ash settling point, Unit 4 seal water, floor drains, equipment drains, demineralizer/regenerator wastes, equipment wash water systems, bottom ash recycle system blowdown, stormwater from yard drains and coal pile runoff.
 - Outfalls 005 and 007: intake screen wash water.
 - Outfall 014: 19.2 MGD maximum daily discharge of condenser cooling water plus intermittent heat recycle cooling water up to a temperature of 115°F within the four-hour period used to control biological fouling of the condenser systems.
 - Outfall 015: emergency spillway overflow.

Vessel sewage pump-out facilities:

1. Winter Island Dock, Salem.

USE ASSESSMENT

Aquatic Life

No "Fish kills" (excess of 500 or more fish) caused by the USGenNE discharge of thermal effluent at temperatures in excess of 90°F or temperature rises above 25°F have been reported to DEP (Gil 1999).

As part of the DMF *Study of the Marine Resources of Salem Sound, 1997*, sampling was conducted in Salem Harbor on multiple occasions from January-December (Chase 2000). Beach seining and water quality monitoring were conducted at Pioneer Village and bottom trawling, and nutrient sampling at the Harbor Mouth station.

PIONEER VILLAGE:

- Results of beach seining at Pioneer Village indicated a finfish population dominated by *Menidia menidia* (Atlantic silverside) and *Brevoortia tyrannus* (Atlantic menhaden).
- Dissolved oxygen measurements ranged from 7.7 to 12.8 mg/L. Supersaturation was documented in over 90% of the samples with a mean of 113%.
- The pH ranged from 7.7 to 8.0 SU on the 10 sampling events.

HARBOR MOUTH:

- *Pseudopleuronectes americanus* (winter flounder) and *Raja* spp (skate) dominated the trawls.
- Nutrient samples were collected on 18 dates in 1997. Surface ammonia concentrations ranged from 0.004 to 0.113 mg/L and phosphate from 0.015 to 0.205 mg/L.

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that their areas (N18.0 and 18.1) in Salem Harbor are prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

SUMMARY

Although DMF data suggests no exceedences of the SWQS, the potential impacts of the power plant were not evaluated (see recommendations) therefore the *Aquatic Life Use* is not assessed at this time. The *Shellfishing Use* for this segment is assessed as non-support.

Designated Uses		Status: Salem Harbor (MA93-21)
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 1.62 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Salem Harbor MA93-21)

- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).
- Evaluate the seine and trawl data in the DMF report titled *A Study of the Marine Resources of Salem Sound, 1997* (Chase 2000) for use in the assessment of the *Aquatic Life Use*. Request assistance from CZM and DMF to develop standard methods for interpreting marine biological monitoring data as part of the *Aquatic Life Use* assessment.
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.
- USGenNE
USGenNE discharges once-through cooling water to Salem Harbor. Aquatic resources (fish, shellfish, etc.) within receiving waters may be susceptible to the impacts of the discharge. Additional monitoring should be implemented and results provided to the regulatory agencies to identify possible impacts. During the next permit review, additional data collection/monitoring should be required of the power plant. In general DEP recommends that all power plant operators in the Commonwealth collect the following types of information.
 1. Flow (cooling water use schematic, permit limits and location of intake(s) and discharge(s))
 2. Intake design (should include velocity across screens, mesh size, information as to the ability to rotate screens, mechanisms for removing impinged fish, fish return systems)
 3. Discharge (thermal limit, discharge structure design)
 4. Monitoring program (Discharge Monitoring Reports type and report frequency)
 5. Biological monitoring (description of any biological monitoring programs required by permit)
 6. Fish kill (description of any specific fish kill provisions included in permit)
 7. Hydrological monitoring

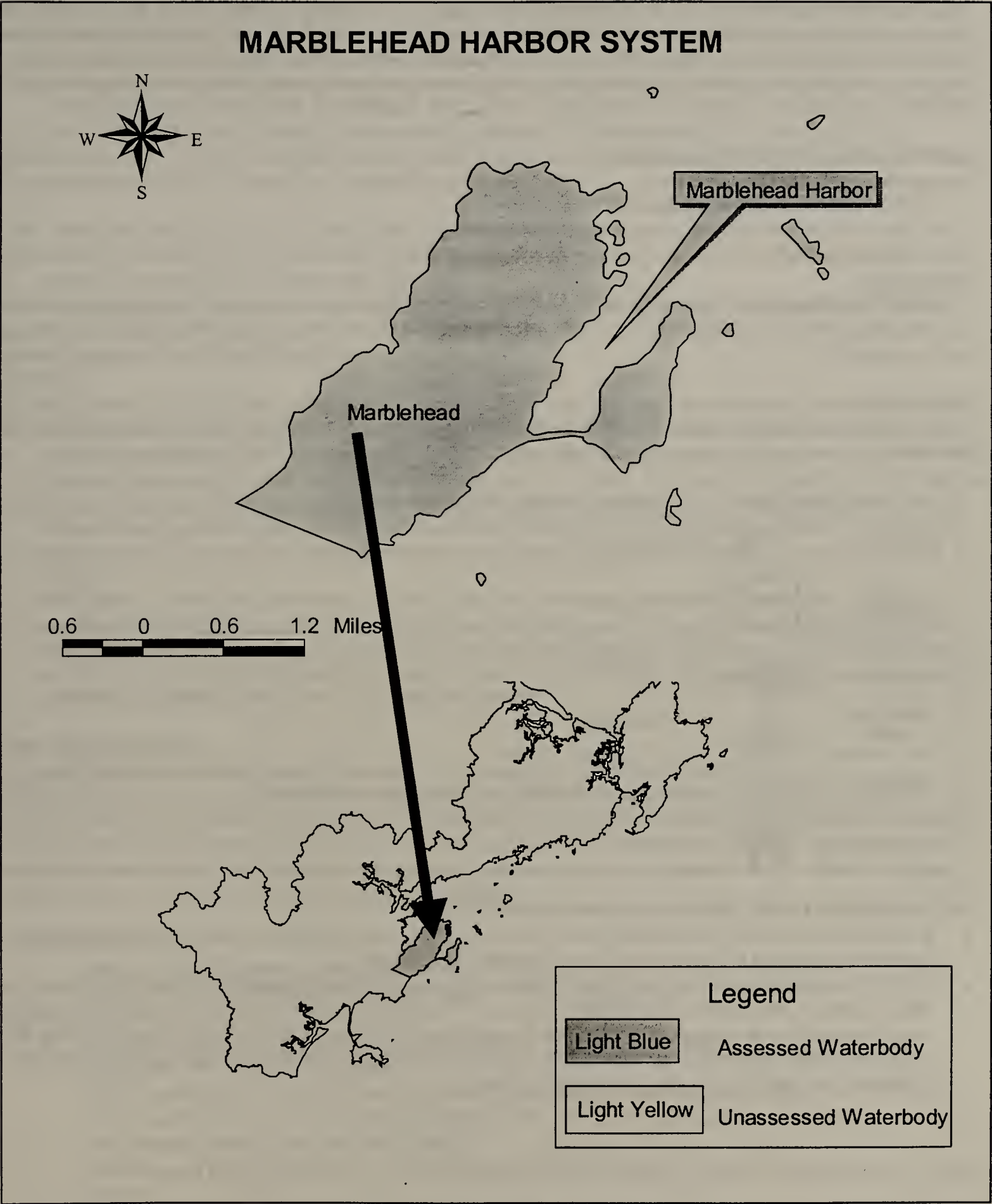
RECOMMENDATIONS Continued (Salem Harbor MA93-21)

Specific issues identified with USGenNE's discharge permit include:

1. Currently USGenNE's discharge permit requires temperature measurements at the intake water box of Units 3 and 4 as well as 2 feet below the surface of the discharge water. Temperatures were also to be monitored continuously to determine the daily range and average. These data were not presented to DEP. The Discharge Monitoring Reports (DMR) did not provide the data necessary to determine compliance with these permit requirements. Establish if the obligatory temperature data is being collected and enforce the requirement that the relevant data be provided to the regulatory agencies.
2. The effects of the thermal and/or "biocide" containing discharge(s) from the USGenNE in Salem Harbor are unknown at this time. The current practice of multiple unit "biocide" treatment should perhaps be changed to single unit treatment (as required at Brayton) to minimize the concentration of residual into Salem Harbor.
3. Establish a power plant task force/technical advisory committee to evaluate the impacts of the USGenNE discharge as well as the combined effects of other point and non-point source discharges to these receiving waters.
4. Investigate the impacts of impingement and entrainment on fish populations in this segment.

MARBLEHEAD SYSTEM

Marblehead Harbor has no named tributaries discharging to it. An assessment follows for Marblehead Harbor.



MARBLEHEAD HARBOR (SEGMENT MA93-22)

Location: Marblehead. Length/area: 0.56 mi². Classification: Class SA.

SEGMENT DESCRIPTION

This is a Class SA estuary. For the purpose of this report, the harbor is defined as the waters inside of an imaginary line drawn from Fort Sewell to Marblehead Light. As of 15 April 1997, a review of the Chapter 21E sites (hazardous waste sites) indicate several locations where minor spillage of petroleum or hazardous waste was reported. These include the following release tracking numbers in this area: 3-0003235, 3-0004795, 3-0004414, 3-0000605, 3-0002300, 3-0001683, 3-0000830, and 3-0004472.

WITHDRAWALS AND DISCHARGES

Vessel sewage pump-out facilities:

1. Cliff Street Boatyard, Marblehead.

USE ASSESSMENT

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that their area (N20.0) in Marblehead Harbor is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

SUMMARY

Due to the lack of current water quality data, shellfishing is the only use assessed in this segment. The *Shellfishing Use* is assessed as non-support for a 0.56 mi² area due to a DMF prohibition.

Designated Uses		Status: Marblehead Harbor (MA93-22)
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 0.56 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Marblehead Harbor MA93-22)

- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where more intensive fecal coliform sampling should be conducted. Continue to review the data/information generated by Salem Sound 2000's volunteer monitoring program and if possible include in the next assessment reporting process.

SALEM SOUND (SEGMENT MA93-25)

Location: Beverly/Manchester. Length/area: 10.01 mi². Classification: Class SB.

SEGMENT DESCRIPTION

For the purpose of this report, Salem Sound is defined as the waters inside of an imaginary line drawn from Marblehead Light northeast to the southwestern point on Bakers Island, Beverly from the northwestern point on Bakers Island to Gales Point, Manchester. This segment excludes Marblehead, Salem, Beverly and Manchester harbors that are defined as separate segments in this report.

The town of Manchester is under an administrative consent order restricting the number of new connections to the WWTP treatment plant system except by written authorization by the Board of Health. The Manchester WWTP facility has recently been upgraded.

DEP managed grant projects that are collecting data to evaluate water quality conditions and set forth remediation measures to improve water quality conditions in this segment include:

- 104(b)(3) Project 97-08—Salem Sound Nutrient Monitoring.
- Massachusetts Watershed Initiative Project 99-11/MWI -- North Coastal Watershed Assessment

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0100501--The South Essex Sewer District WWTP (SESD) discharges treated secondary wastewater to Salem Sound. The facility has recently (June 1998) been upgraded to secondary treatment and discharges through a 660 foot multiport diffuser. Dechlorination was also added to the treatment facility and became operational in the spring of 1998. The treatment plant is under start up conditions and working to establish its standard operational procedures. The permit limit for whole effluent toxicity after implementation of secondary treatment is $LC_{50} \geq 100\%$ effluent. Testing is required using two species, *Menidia beryllina* and *Mysidopsis bahia* in February, April, June and August.
2. MA0100871--The Manchester By-The-Sea WWTP discharges 0.67 MGD of treated municipal wastewater to Massachusetts Bay near to Sauli Rock outside of Manchester Harbor proper. The Manchester POTW was upgraded from primary to a full secondary facility as of August 1998 per the requirements of the Administrative Consent Order AP-BO-92-101. All new units were on-line as of an inspection conducted by DEP on 10 February 1999.

USE ASSESSMENT

Aquatic Life

As part of the DMF *Study of the Marine Resources of Salem Sound, 1997*, beach seining (West Beach, Beverly) and bottom trawling (Haste Channel, Beverly Cove and Marblehead Harbor) were conducted in this segment on multiple occasions from January-December of 1997 (Chase 2000). Additionally, DMF conducted water quality monitoring at five stations within this segment (Beverly Cove, Beverly Harbor, Haste Channel, Haste Outfall and Marblehead Harbor).

WEST BEACH

- Results of beach seining indicated *Menidia menidia* (Atlantic silverside) and *Clupea harengus* (Atlantic herring) dominated the West Beach finfish population.

BEVERLY COVE

- *Pseudopleuronectes americanus* (winter flounder) and *Tautoglabrus adspersus* (cunner) dominated the Beverly Cove trawls.
- DO concentrations were very similar in the surface and bottom waters (range 7.8 - 13.8 mg/L) with supersaturation occurring approximately 66% of the time (no samples collected pre-dawn).
- Temperature readings all met the SWQS.
- The instream pH ranged from 7.7 to 8.1SU with similar readings in both the surface and bottom waters.

BEVERLY HARBOR

- *Pseudopleuronectes americanus* (winter flounder) and *Gadus morhua* (Atlantic cod) dominated Beverly Harbor trawls.
- DO concentrations were very similar in the surface and bottom waters (range 7.1 - 13.0 mg/L) with supersaturation occurring approximately 63% of the time (no samples collected pre-dawn).
- Temperature readings all met the SWQS.
- The instream pH ranged from 7.7 to 8.1SU with similar readings in both the surface and bottom waters.

HASTE CHANNEL

- The Haste Channel trawls were dominated by *Pseudopleuronectes americanus* (winter flounder) and *Raja* spp (skate).
- DO concentrations were very similar in the surface and bottom waters (range 7.1 - 13.2 mg/L) with supersaturation occurring approximately 60% of the time (no samples collected pre-dawn).
- Temperature readings all met the SWQS.
- The instream pH ranged from 7.6 to 8.1SU with similar readings in both the surface and bottom waters.

HASTE OUTFALL

- DO concentrations were very similar in the surface and bottom waters (range 7.0 - 13.3 mg/L) with supersaturation occurring approximately 66% of the time (no samples collected pre-dawn).
- Temperature readings all met the SWQS.
- The instream pH ranged from 7.7 to 8.1 SU with similar readings in both the surface and bottom waters.

MARBLEHEAD HARBOR

- DO concentrations were very similar in the surface and bottom waters (range 7.8 - 13.8 mg/L) with supersaturation occurring approximately 63% of the time (no samples collected pre-dawn).
- Temperature readings all met the SWQS.
- The instream pH ranged from 7.8 to 8.0 SU with similar readings in both the surface and bottom waters.

The South Essex Sewer District WWTP (SESD) has conducted many acute and chronic toxicity tests of the primary treatment plant effluent. The effluent was acutely toxic to mysid shrimp (*Mysidopsis bahia*) and silverside minnows (*Menidia beryllina*) in all test events. The primary effluent also exhibited variable acute and/or chronic toxicity to sheepshead minnow (*Cyprinodon variegatus*). Secondary treatment at the SESD facility went on line in June 1998. Two acute whole effluent toxicity tests were performed in June and August 1998. The LC₅₀s ranged between 94 and >100% effluent indicating a much improved quality effluent with regard to acute toxicity.

The Manchester WWTP facility has conducted acute toxicity testing of their effluent. Between January 1993 and January 1998 a total of eleven test events have been conducted. No acute toxicity has been detected by either the *Menidia beryllina* or *Mysidopsis bahia* test organisms although the *M. beryllina* appears to be more sensitive. Survival of these test organisms exposed to ambient water collected off Sauli Rock has not been less than 85%. The facility has however reported numerous exceedences of permits limits, many of which were related to inflow/infiltration (physical) problems and saltwater intrusion as well as violations of the residual chlorine limit. The Discharge Monitoring Reports (DMRs) starting in August 1998 depicted a noticeable improvement in effluent quality. Prior to August 1998 violations were common for BOD, TSS, SS, Flow, fecal coliforms and % removal of BOD and SS. Since then there has been a single exceedence for TRC in August 1999 (1.3 mg/L) the limit being 1.0 mg/L. The exceedence was traced to a problem in the aeration tank blower unit and low flows into the plant. The problem has been corrected as of September 1999 and there have been no additional exceedences reported.

Based on these data, the *Aquatic Life Use* is assessed as support in Salem Sound.

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that areas N16 and N19.0 in Salem Sound are prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

Aesthetic

DMF also recorded Secchi disk depths at the five water quality stations monthly in 1997 (Beverly Cove, Beverly Harbor, Haste Channel, Haste Outfall and Marblehead Harbor). With the exception of one sampling date (28 August 1997) all Secchi disk readings were greater than 2.5 m with the majority of the readings >3.0m. Based on these data the *Aesthetics Use* is supported in this segment.

SUMMARY

Although the SESD discharge has shown to be toxic to multiple test organisms, recent toxicity testing and water quality testing has indicated improved conditions. Therefore the *Aquatic Life Use* is assessed as support for this entire segment. The DMF water quality data (visual observation, Secchi disk) indicated no objectionable turbidity thereby supporting the *Aesthetics Use*. Due to a DMF prohibition, the *Shellfishing Use* is non-support.

Designated Uses		Status: Salem Sound (MA93-25)
Aquatic Life		SUPPORT. The 10.01 mi ² area supports this use.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The 10.01 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		SUPPORT. The 10.01 mi ² area supports this use.

RECOMMENDATIONS (Salem Sound MA93-25)

- Evaluate the seine and trawl data in the DMF report titled *A Study of the Marine Resources of Salem Sound, 1997* (Chase 2000) for use in the assessment of the *Aquatic Life Use*. Request assistance from CZM and DMF to develop standard methods for interpreting marine biological monitoring data as part of the *Aquatic Life Use* assessment.
- SS2000 has established an extensive database of fecal coliform data with sampling collected at over 300 stations in the Salem Sound Subwatershed. These data should be utilized as a screening tool to identify where additional fecal coliform sampling should be conducted. Additionally, where these data indicate extremely high levels of fecal coliform bacteria, a high priority should be placed on source identification and remediation.
- Assess the results of the ongoing grant projects mentioned above as to the improving of water quality conditions (reduction of bacteria, nutrient, toxic substance, and sediment loadings) through post implementation monitoring.
- **SOUTH ESSEX SEWER DISTRICT WWTP (SESD)**
 1. Although the SESD primary treated effluent has exhibited acute toxicity, the new secondary treatment has improved effluent quality somewhat. The secondary treatment effluent, however, is still not meeting permit limits and actions should be taken to rectify this condition.
 2. Continue to review SESD toxicity testing results to identify when the permit limits are met.
 3. Dechlorination was added to the facility in 1998. Conduct total residual chlorine monitoring to identify if the new treatment has improved conditions.

RECOMMENDATIONS Continued (Salem Sound MA93-25)

- MANCHESTER-BY-THE-SEA WWTP

1. The WWTP plant was upgraded in 1998. Continue to review DMRs to verify compliance with permit limits.
2. Since *Menidia beryllina* appears to be the more sensitive test organism to the WWTP effluent, it is recommended that the facilities toxicity testing requirements be reduced to only *M. beryllina* in their next permit.
3. 1997 DMR reports indicated a manually paced chlorination system. Determine if this system has recently been replaced.

NAHANT BAY (SEGMENT MA93-24)

Location: Swampscott, Lynn, and Nahant. Length/area: 5.27 mi². Classification: Class SA.

SEGMENT DESCRIPTION

This is a Class SA estuary. For the purpose of this report, the harbor is defined as the waters inside of an imaginary line drawn across Galloupes or Phillips Point, Swampscott, to East Point, Nahant.

DEP managed loan projects that should be improving water quality conditions in this segment include: SRF- Lynn Water and Sewer Commission CSO Consolidation Conduit and Storage/Treatment – Stacey Brook.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0100552 for the Lynn Water and Sewer Commission (LWSC) has a total of eight discharge points only one of which discharges to this segment (#006). Outfalls #001, #002, #004, #005, and #007 are presented in the Lynn Harbor (segment MA93-23) and outfalls #003 and #008 discharge to Saugus River (segment MA93-14). Outfall #006, Sanderson Avenue is a wet weather CSO that discharges into Stacy Brook. This brook discharges to Kings Beach. As part of Phase I of the LWSC CSO facilities plan, the flow coming from the Lynn side of the system will be separated from the Swampscott side of the drainage. The Sanderson Ave overflow discharges approximately 200 MG/year of CSO (without Phase I separation) at a frequency of approximately 40x/year. Upon completion of Phase II, outfall #006 will be eliminated. LWSC is under an EPA Administrative Consent Order to eliminate all CSOs.
2. The Swampscott WWTP discharge MA0101907 to Nahant Bay was tied into the LWSC facility on 2 June 1992. The status of the three remaining discharges (002, 003, and 004) of contaminated stormwater including urban runoff and an intermittent discharge of untreated combined sewage (all possibly chlorinated) to Nahant Bay and Stacey Brook is currently unknown. These outfalls are briefly described below:
 - 002: Sculpin Way Drain discharge of contaminated stormwater, including urban runoff and chlorine to Nahant Bay.
 - 003: Marshall Brook Drain discharge of contaminated stormwater, including urban runoff and chlorine to Nahant Bay.
 - 004: New Ocean Street Underdrain intermittent discharge of untreated combined sewage and chlorine to Stacey Brook.

USE ASSESSMENT

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that areas N22.0, 22.1, 23.0 and 24.0 in Nahant Bay are all prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

Recreation

The Metropolitan District Commission (MDC) conducted fecal coliform bacteria monitoring at Kings Beach and Nahant Beach on a weekly basis during the summer months (June – August). MDC's sampling was conducted at three locations to evaluate bacteria levels near the Stacey Brook CSO outfall: approximately 700 feet north of the outfall representing the "Swampscott side"; the outfall itself; and approximately 1600 feet south of the outfall representing the "Lynn side" of the beach area. Samples were also collected at three locations along Nahant Beach. During the summer of 1998, due to elevated levels of fecal coliform bacteria, Kings and Nahant beaches were "posted" by MDC and therefore the *Primary Contact Recreational Use* is assessed as non-support (G&L Laboratories 1998). It should be noted, however, that this assessment relates primarily to areas designated specifically for *Primary Contact Recreation* (swimming beaches) and it is highly likely that the deeper water portions of Nahant Bay would meet criteria. Based on the MDC survey results (Table 4) the *Secondary Contact Recreational Use* is assessed as support for Nahant Bay.

Table 4. Metropolitan District Commission (MDC) fecal coliform bacteria data (cfu/100 mL) for Kings and Nahant beaches, summer 1997.

1997 Sample Date	Swampscott	Stacey Brook	Kings Beach	Lynn @ Nahant St	Nahant @ Bath House	Nahant @ Halfway House
18 June	140	588	85	15	55	40
25 June	<5	950	25	<5	35	95
1 July	95	275	5	20	10	30
9 July	40	480	30	<5	70	35
16 July	45	50	145	40	25	30
23 July	60	>4000	1580	130	10	50
30 July	1720	1320	20	20	10	15
6 August	65	<5	15	10	5	No sample
13 August	175	Missing	Missing	Missing	10	310
20 August	Missing	2420	10	45	Missing	30
27 August	175	Missing	25	Missing	Missing	5

SUMMARY

The status of the four DMF shellfishing areas in this segment is prohibited and therefore the *Shellfishing Use* is assessed as non-support. MDC beach closures render the *Primary Contact Recreational Use* non-support a result of elevated levels of fecal coliform bacteria. Based on the MDC data, the *Secondary Contact Recreational Use* is assessed as support.

Designated Uses

Status: Nahant Bay (MA93-24)

Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 5.27 mi ² area does not support this use based on the MDC beach closures (see discussion above).
Secondary Contact		SUPPORT. The entire 5.27 mi ² area supports this use.
Shellfishing		NON-SUPPORT. The entire 5.27 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Nahant Bay MA93-24)

- Monitor the post-implementation effectiveness of the Lynn Water and Sewer Commission CSO Consolidation Conduit and Storage/Treatment – Stacey Brook Project. Establish the timetable for completion of this project.
- Investigate possible sources of fecal coliform bacteria, including illicit sewer connections, failing septic systems, CSOs etc. Determine the extent to which these sources are causing beach and shellfish closures.
- Assess the results of the ongoing loan project mentioned above as to the improving of water quality conditions (reduction of bacteria, nutrient, toxic substance, and sediment loadings) through post implementation monitoring.

Lynn Water and Sewer Commission

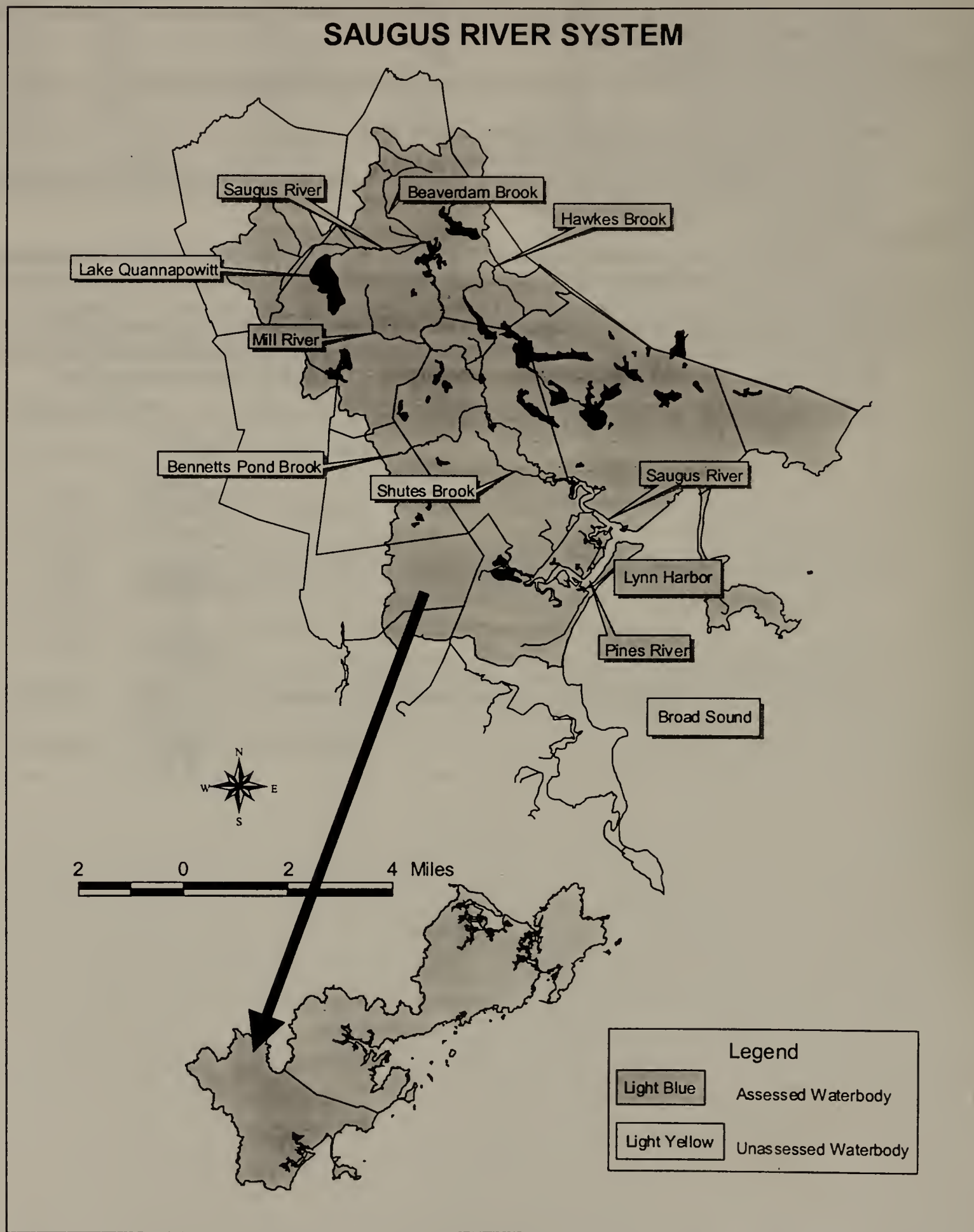
1. MA0100552 - Lynn Water and Sewer Commission (LWSC) determine the status of the LWSC CSO facilities plan.
2. Identify if either Phase I or Phase II has been completed.
3. Establish if discharge #006 has been eliminated.
4. Conduct wet weather fecal coliform bacteria sampling to determine if the elimination of the CSO is improving water quality in this segment.

Swampscott WWTP

1. Clarify the status of the old Swampscott CSO outfall discharges 002, 003, and 004 associated with the NPDES permit MA0101907. Identify if these three outfalls are still discharging to this segment.
2. Identify if the Swampscott sewer tie-in to the LWSC still contributes to LWSC outfall #006.
3. Establish if the Swampscott NPDES permit has been closed out. If not, determine if there is a need to close it out or if the town of Swampscott needs to maintain a permit and conduct monitoring of the discharges (002, 003, and 004).

SAUGUS RIVER SYSTEM

This system originates at the outlet of Lake Quannapowitt in Wakefield and eventually flows into the estuary downstream of the Saugus River Ironworks in Saugus. The river receives flow from four tributaries in its freshwater reach including Beaverdam Brook, Mill River, Hawkes Brook and Bennetts Pond Brook. Shutes Brook discharges into the tidal Saugus River, which is joined by the Pines River. They flow into Lynn Harbor, which eventually discharges into Broad Sound. Assessments follow for the Saugus River, Beaverdam Brook, Mill River, Hawkes Brook, Pines River and Lynn Harbor.



SAUGUS RIVER (SEGMENT MA93-34)

Location: Outlet of Lake Quannapowitt, Wakefield to the Lynn Water Sewer Commission diversion canal that discharges to Hawkes Pond, Wakefield/Lynnfield. Length/area: 3.1 river miles.

Classification: Class B, Treated Water Supply.

SEGMENT DESCRIPTION

The Saugus River originates at outlet of Lake Quannapowitt in Wakefield. This Class B Treated Water Supply segment of the Saugus River flows in an easterly direction and becomes the border between Wakefield and Lynnfield just west of Route 128 Interchange 41. The stream flows through a wetland area and is joined by Beaverdam Brook, a tributary draining the central area of Lynnfield. At this point, the Saugus River turns south, flows past the Colonial Golf and Country Club and into a small impoundment where water is withdrawn to supply public water the city of Lynn. As of 15 April 1997, a review of the Chapter 21E sites (hazardous waste sites) indicate several locations where minor spillage of petroleum or hazardous waste was reported. These include the following release tracking numbers in this area: 3-000042, 3-0004413, 3-00001302, 3-00001005, 3-00003080, 3-00003002671, and 3-00030001210.

WITHDRAWALS AND DISCHARGES

WMA:

1. Lynn Water and Sewer Commission is registered (31816302) to withdraw 8.93 MGD and permitted (9P31816302) to withdraw an additional 1.28 MGD for a total withdrawal of 10.21 MGD from six sources. One of the six sources is the Saugus River.
2. Colonial Sheraton Country Club, Lynnfield permitted (9P31816402) to withdraw 0.28 MGD from a pond.

NPDES:

1. MA0026247 Power Products, Inc., Wakefield discharges non-contact cooling water and stormwater runoff to "a surface drainage channel to the Saugus River (approx. 1 mile from discharge point)".

USE ASSESSMENT

Aquatic Life

Water quality sampling was conducted by DEP DWM at one station along this segment of the Saugus River—SR04 downstream from the outlet of Lake Quannapowitt in Wakefield on two occasions (June and July) in 1997. The data sets are presented in Appendix B, Tables B3-B4 of this assessment report.

- Both dissolved oxygen readings were extremely low measuring 2.3 and 2.9 mg/L (% saturation of 25 and 33), respectively. It should be noted, however that all measurements were made midday and do not represent worse-case (pre-dawn) conditions.
- Temperature readings on both occasions were above 20 °C (21.4 and 21.6). Conductivity measurements were 668 and 674 µS/cm, elevated for a freshwater system. The pH was 6.6 SU on both sampling events.
- Total suspended solids were higher in June (134 mg/L) than in July (11 mg/L).
- Nutrient concentrations were somewhat elevated with ammonia nitrogen concentrations of 0.66 and 0.93 mg/L and total phosphorus of 0.08 and 0.14 mg/L. The higher measurements were in July.

Stream discharge monitoring was conducted by DEP DWM downstream from the outlet of Lake Quannapowitt in Wakefield (SR04) on two occasions in 1997. The data sets are presented in Appendix B, Table B2 of this assessment report.

- Discharge in the Saugus River was extremely low (0.05 and 0.02 cfs) in June and July, respectively, at this station.

Stream flow was measured by DEM at this end of this segment in the LWSC Diversion canal (MA DEM 1998). On 29 July 1997, 0.17 cfs was measured. Flow was even less on 9 September and 21 October 1997 (0.13 and 0.07 cfs, respectively). The highest flow was measured on 19 November 1997 (8.8 cfs).

Based on these data the *Aquatic Life Use* is assessed as partial support due to low levels of oxygen saturation instream during mid-day and concerns for lower levels under worse-case (pre-dawn) hours and elevated nutrients. This assessment is for the stream reach from the headwaters at the outlet of Lake Quannapowitt to its entrance to the large wetland downstream of Route 128 (approximately 1.0 river miles). The lower 2.1 miles are not assessed for this use.

Fish Consumption

Fish contaminant monitoring was conducted by DEP in Lake Quannapowitt in May 1998. Results are presented in Appendix B, Table B7 and discussed in the Lake/Pond Assessments section of this report. MA DPH has reviewed these data and no fish consumption advisory has been issued.

Recreation

Fecal coliform monitoring was conducted by DEP DWM at one station along this segment of the Saugus River—SR04 downstream from the outlet of Lake Quannapowitt in Wakefield in June and July of 1997 (Appendix B, Table B5). Only two fecal coliform samples were collected from this segment and neither result exceeded the 200 cfu/100 mL criteria established in the SWQS.

The Saugus River Watershed Council sampled fecal coliform bacteria at two locations in this reach of the Saugus River—at the outlet of Lake Quannapowitt (SR2) and in the ponded area just upstream of the “Lynn Dam” at the Colonial Golf Course in Lynnfield (SR3) in 1996, 1997 and 1998. This screening level data identified varied results with occasionally elevated levels occurring on both wet and dry weather sampling events (Saugus River Watershed Council 1994).

Aesthetics

The aesthetic quality of this segment is degraded. Elevated nutrient levels appear to be contributing to instream enrichment in this segment of the Saugus River as evidenced by visual turbidity, algal blooms, and extensive macrophyte growth. Physical alteration such as channelization, encroachment, highway and railroad construction diminishes the aesthetic quality of the Saugus River as it flows through Reedy Meadows (DEP 1998d).

The Saugus River Watershed Council water quality monitors reported that the surface of Lake Quannapowitt was completely covered by duckweed from late spring throughout the sampling season (Saugus River Watershed Council 1994).

SUMMARY

The data collected in this reach of the Saugus River identifies low dissolved oxygen coupled with elevated nutrients therefore the *Aquatic Life Use* is assessed as partial support. The combined results of both DEP DWM's and the Saugus River Watershed Council's fecal coliform data (1994-1998) was not extensive enough to evaluate the *Recreational* uses. Visual turbidity, algal blooms, and extensive macrophyte growth impair the *Aesthetics Use* throughout the entire segment.

Designated Uses		Status: Saugus River (MA93-34)
Aquatic Life		PARTIAL SUPPORT. The 1.0 mile reach from the headwaters to the large wetland just downstream from Route 128 is evaluated as partial support for this use based on low DO and elevated nutrients. NOT ASSESSED. The remaining 2.1 miles are not assessed at this time.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Aesthetics		NON-SUPPORT. The entire 3.1 mile reach is evaluated as non-support for this use evidenced by turbidity, algal blooms, and extensive macrophyte cover as well as physical alterations (channelization, encroachment).

RECOMMENDATIONS (Saugus River MA93-34)

- Conduct additional water quality monitoring in this segment with better spatial and temporal coverage to establish the extent of the low dissolved oxygen and elevated nutrients. Monitoring should include pre-dawn DO measurements, nutrients, and Hydrolab parameters.
- Assess the impact of the water withdrawal on the flow regime of the Saugus River. Minimize the water withdrawal (maximize flow) to the extent possible.
- Conduct more frequent fecal coliform sampling during both dry and wet weather conditions, bracketing major changes in land use. This additional data collection is necessary to evaluate the status of the *Primary and Secondary Contact Recreational* uses.
- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).

Power Products Inc.

1. Identify the discharge point locations (Saugus River or unnamed tributary).
2. The facility is functioning under a permit that expired in March 1991. Either the facility should apply for coverage under the general permit or the NPDES individual permit should be reissued with appropriate limits/monitoring requirements.

Lynn Water and Sewer Commission

1. Identify how the Lynn Water and Sewer Commission manipulates water in this area. If increased streamflows could be achieved through changes in the water supply system incorporate into WMA permit.

BEAVERDAM BROOK (SEGMENT MA93-30)

Location: Headwaters west of Main Street, Lynnfield to confluence with Saugus River, Lynnfield.
Length/area: 2.5 river miles. Classification: Class B.

SEGMENT DESCRIPTION

Beaverdam Brook originates just east of Main Street in Lynnfield and flows in a westerly direction through a portion of Cedar Swamp. Beaverdam Brook then turns south and crosses under Chestnut and Main streets and enters an extensive wetland area prior to flowing into the Saugus River just north of the Lakefield/Lynnfield town line. Land use in the subwatershed includes a pumping station, a golf course (Lynnfield Center Golf Club), Lynnfield Jr. High School, and Camp Curtis Guild National Guard Reservation.

WITHDRAWALS AND DISCHARGES

WMA:

1. Lynnfield Center Water District is registered (31816401) to withdraw 0.32 MGD from three wells.

NPDES:

1. MAG640017 Lynnfield Center Water District was issued a general water treatment plant discharge permit in November 1995.

USE ASSESSMENT

Aquatic Life

DEP DWM sampled one water quality station in Beaverdam Brook, BB01 (just upstream of Chestnut Street in Lynnfield). Sampling was conducted on six occasions between June 1997 and January 1998. The complete data sets are presented in Appendix B, Tables B3 and B4 of this assessment report.

- Dissolved oxygen measurements ranged between 5.2 and 10.1 mg/L (44 - 71% saturation) during the summer. None of these measurements were pre-dawn and therefore do not represent worse-case conditions.
- Alkalinity measurements were somewhat higher than other freshwater streams sampled in the North Coastal Watershed ranging between 99 and 250 mg/L. Instream pH measurements (6.5 to 7.4 SU) were within the SWQS for a Class B waterbody.
- Conductivity measurements ranged between 317 and 461 $\mu\text{S}/\text{cm}$, somewhat elevated for a freshwater system. Suspended solids ranged between <1 and 22 mg/L.
- Ammonia nitrogen levels were very low (<0.02 – 0.04 mg/L), while nitrate nitrogen ranged from 1.3 to 2.6 mg/L. Total phosphorus concentrations were as high as 0.11 mg/L.

Streamflow measurements in Beaverdam Brook at Chestnut Street in Lynnfield conducted by DEP DWM and DEM personnel were very low (Appendix B, Table B2, MA DEM 1998). Less than 0.1 cfs of streamflow was measured between June and October 1997. The highest flow was measured in January 1998 (1.9 cfs).

The Lynnfield Water Treatment Facility discharges approximately one mile upstream of the DEP DWM BB01 sampling station. On their April to June 1998 discharge monitoring report (DMR), they reported a pH minimum of 7.8 and maximum of 9.9 SU (Dallaire 1999). The maximum pH violates the permit limit. Personnel at the water treatment plant were contacted to determine the potential cause(s) of the exceedence. The water treatment facility implements corrosion control and the pH is usually 7.5 SU. They also utilize activated charcoal to remove Fe and Mg and these filters are back-washed into a lagoon. The lagoon has a sand base with an underdrain collection system that discharges usually once a day for approximately 10 minutes. They estimated the discharge volume at <10,000 GPD.

Low DO concentrations and saturation, likely due to low flow, impair the *Aquatic Life Use* for the entire length of Beaverdam Brook.

Recreation

One fecal coliform bacteria station in Beaverdam Brook (BB01) was sampled on six occasions between June 1997 and January 1998 by DEP DWM. An additional fecal coliform bacteria sample was also collected in October 1997 in Beaverdam Brook (BB01A) downstream of Chestnut Street bridge in Lynnfield. The complete data set is presented in Appendix B, Table B5 of this assessment report.

- Fecal coliform bacteria levels were elevated (1,600 and 2,000 cfu/100 mL) in two samples collected in July and September 1997. The elevated counts were collected during dry weather conditions. The remaining four fecal coliform bacteria samples collected from station BB01 ranged between <20 and 200 cfu/100mls.
- The one sample collected at BB01A resulted in a count of 400 cfu/100mls.

The *Primary Contact Recreational Use* is assessed as non-support due to elevated levels of fecal coliform bacteria under dry weather sampling conditions however, the *Secondary Contact Recreation* is supported.

Aesthetics

The stream reach near the sampling station had a well-developed riparian zone and was shaded by overhanging vegetation with no obvious signs of nonpoint source pollution (DEP 1998d). The *Aesthetics Use* is therefore assessed as support.

SUMMARY

Low dissolved oxygen (concentration and % saturation) likely related to the low flow conditions impair (partial support) the *Aquatic Life Use* for the entire 2.5 mile length of Beaverdam Brook. Based on elevated fecal coliform bacteria counts the *Primary Contact Recreational Use* is assessed as non-support while levels were within the SWQS for the *Secondary Contact Recreation Use*.

Designated Uses

Status: Beaverdam Brook (MA93-30)

Aquatic Life		PARTIAL SUPPORT. The entire 2.5 mile length of this stream is evaluated as partial support. The data collected (particularly dissolved oxygen) indicate levels below standards. Low flow conditions may exacerbate the problem.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 2.5 mile length of this segment does not support this use because of elevated levels of fecal coliform bacteria originating from unknown source(s).
Secondary Contact		SUPPORT. The entire 2.5 mile length of this segment supports this use.
Aesthetics		SUPPORT. The entire 2.5 mile length of this segment supports this use.

RECOMMENDATIONS (Beaverdam Brook MA93-30)

- Sample for fecal coliform bacteria during wet and dry weather conditions to establish the extent of the elevated levels. Investigate sources of fecal coliform bacteria inputs to this segment (illicit sewer connections, failing septic tanks, etc.).
- Conduct water quality monitoring of dissolved oxygen during worse-case (pre-dawn) conditions to characterize the extent of the low dissolved oxygen readings.
- Assess the potential impacts of the water withdrawals on the flow regime of Beaverdam Brook. Minimize the water withdrawal (maximize flow) to the extent possible.

Lynnfield Water Treatment Facility

1. The Lynnfield Water Treatment Facility discharge is to a Class B (not SB) surface water. The pH limits in the general permit for a Class B discharge are 6.5 to 8.3 SU (not 6.5 to 8.5 SU as is currently printed on the DMR forms). When a new general permit is reissued the DMR requirements should be corrected.
2. Whether or not the Lynnfield Water Treatment Facility's effluent quality is highly variable or the high pH measurement was just an outlier remains a question. Additional monitoring of the effluent as well as instream (upstream/downstream) pH monitoring is warranted to identify the duration and magnitude of the permit violations.

SAUGUS RIVER (SEGMENT MA93-35)

Location: From the Lynn Water & Sewer Commission diversion canal, Wakefield/Lynnfield to the Saugus Iron Works, Saugus. Length/area: 5.3 river miles. Classification: Currently in the SWQS as a Class SB however, this segment is not tidally influenced and therefore should be a Class B.

SEGMENT DESCRIPTION

This segment of the Saugus River is currently classified as a Class SB waterbody. The Saugus River drains wetlands in Reading and Wakefield without picking up much volume or velocity. Downstream from the diversion canal (water intake to Hawkes Pond), the Saugus River crosses under Route 128 and continues to flow in a southerly direction marking the town boundaries between Wakefield and Lynnfield. Immediately south of the Route 129 culvert (Water Street) the river picks up the flow of Mill River. The course of the Saugus River is easterly then southeast as it meanders around the east side of the Breakheart Reservation where it is joined by Hawkes Brook from the north. The river then crosses under Route 1 and picks up flow from Bennetts Pond Brook and meanders southeast until it reaches the Saugus Iron Works. Downstream from this point it becomes tidally influenced.

WITHDRAWALS AND DISCHARGES

None known.

USE ASSESSMENT

Aquatic Life

The most available smelt spawning habitat in the North Coastal Watershed is in the Saugus River near the Saugus Iron Works (Chase 1992), although egg deposition in 1988 and 1990 did not approach full utilization of the available habitat for reasons unknown. Three observations of unpermitted discharges were documented by DMF from the Henkel Corporation property (Chase 1992). Although this facility closed its operation in 1991, the proximity of the discharge to the prime egg deposition habitat was of concern to DMF.

DEP DWM conducted water quality sampling at three stations along this segment of the Saugus River—Salem Street, Wakefield/Lynnfield (SR03), Route 1, Saugus (SR02) and Saugus Iron Works in Saugus (SR01). The complete data sets are presented in Appendix B, Tables B3 - B4 of this assessment report.

- The 11 dissolved oxygen measurements ranged from 4.8 to 13.0 mg/L with saturation between 54 and 92%, however none of these measurements were taken before dawn and therefore do not represent worse-case (pre-dawn) conditions.
- Conductivity measurements ranged between 432 and 942 $\mu\text{S}/\text{cm}$, somewhat elevated for a freshwater system. Total suspended solids ranged between <1.0 and 7.0 mg/L. Ammonia nitrogen levels ranged from 0.03 to 0.25 mg/L while total phosphorus levels ranged from 0.02 to 0.1 mg/L.

During the 1997 sampling year, stream discharge was measured on six occasions by DEP DWM and DEM personnel at two locations; Saugus River (SR03) near Salem Street in Wakefield and Saugus River near Route 1 in Saugus (Appendix B, Table B2).

- Discharge in the Saugus River ranged between 0.11 and 5.79 cfs near Salem Street (where only one measurement exceeded 0.2 cfs) and 0.63 and 17 cfs near Route 1 (where only two measurements were <1 cfs).
- Continuous stream discharge measurements for the Saugus River are also recorded at the USGS gaging station, at Saugus Iron Works (USGS gage#01102346).

DEP DWM conducted benthic macroinvertebrate monitoring in the Saugus River (July 1997) at the following locations: upstream from Lowell Street/Salem Street, Wakefield/Lynnfield (SR03), at Camp Nihan, Saugus (SR02B), and downstream from Elm Street, Saugus (SR01). The DEP DWM biomonitoring technical memorandum is presented in Appendix C of this report.

- RBP II analysis ranked station SR03 as non- to moderately impaired when compared to the regional reference station FF01 and, moderately impaired when compared to the Saugus River reference station SR01.
- The sampling reach at SR03 (upstream from Lowell Street/Salem Street) was identified to be vulnerable to nonpoint source pollution and has obvious erosion problems. Habitat limitations along this reach of the Saugus River, however, were primarily related to the low volume of water.

- The most downstream site sampled on the Saugus River was downstream from Elm Street, Saugus (SR01). This site provided the best lotic macroinvertebrate and fish habitat of all the North Coastal Watershed sites and the richness of macroinvertebrate families was high. The RBP II comparison with the regional reference station FF01 produced a score between non-impaired and moderately impaired.

The *Aquatic Life Use* assessment (partial support) was based on the water quality and biology data described above. Dissolved oxygen levels and saturation were occasionally below the water quality standards for a Class B warm water fishery (none of which represented pre-dawn conditions) although the RBP II analysis was limited because of habitat considerations. There are some indications that conditions improve in the lower portion of this segment most probably due to the change in gradient, thereby increasing stream velocity and dissolved oxygen concentrations.

Recreation

Water quality sampling was conducted by DEP DWM at three stations along this segment of the Saugus River—SR03 at Salem Street, Wakefield/Lynnfield, SR02 at Route 1, Saugus and SR01 at Saugus Iron Works in Saugus (Appendix B, Table B5).

- Fecal coliform bacteria sampling results from the Saugus River collected between June 1997 and January 1998 ranged between <20 and 2,800 cfu/100mls.
- The highest fecal coliform bacteria count (400cfu/100mls) was collected from the Saugus River at Salem Street in Wakefield (SR03). Downstream from this location, however, instream fecal coliform bacteria levels were as high as 520 cfu/100 mL at Route 1. This high bacteria count in the Saugus River may be associated with the high counts in the Hawkes Brook tributary collected on the same date.
- Elevated fecal coliform bacteria counts (as high as 2,800 cfu/100 mL) were frequently detected in samples collected at the Saugus Iron Works (SR01).

Based on these data, the *Primary* and *Secondary Contact Recreational* uses are evaluated as support in the upper 3.5 miles of this reach and non-support in the segment downstream from the river's confluence with Hawkes Brook (lower 1.8 miles).

Aesthetics

The river channel, near Saugus Iron Works, (DEP DWM station SR01) had an unaltered natural pattern and with a wide, vegetated zone. This reach had well-developed riffles and runs and a variety of water depths dominated by cobble and boulder (Appendix C). At Camp Nihan near DEP DWM's station SR02B, purple loosestrife was identified in the surrounding wetland (Appendix C). Although purple loosestrife is a non-native species, it produces no direct impact on water quality and therefore it is not considered an impairment of the *Aesthetics Use*. The *Aesthetics Use* of this segment is evaluated as support although localized problems (turbidity, storm drain runoff and iron precipitate) exist (DEP 1998d).

SUMMARY

The *Aquatic Life Use* assessment was based on the water quality and biology data which both indicated impairment (partial support) to this segment. The *Primary* and *Secondary Contact Recreational* uses are evaluated as support in the upper 3.5 miles of this reach and non-support (elevated fecal coliform bacteria) downstream from the river's confluence with Hawkes Brook. The *Aesthetics Use* is supported along the entire length of this segment although turbidity was identified and a non-native was present in the adjoining wetland.

Designated Uses		Status: Saugus River (MA93-35)
Aquatic Life		PARTIAL SUPPORT. The entire 5.3 mile reach is evaluated as partial support for this use resulting from poor habitat quality and low dissolved oxygen levels.
Fish Consumption		NOT ASSESSED.
Primary Contact		SUPPORT. The reach is evaluated as supporting this use in the upper 3.5 miles. NON-SUPPORT. The lower 1.8 miles are impaired due to elevated pathogens.
Secondary Contact		SUPPORT. The reach is evaluated as supporting this use in the upper 3.5 miles. NON-SUPPORT. The lower 1.8 miles are impaired due to elevated pathogens.
Aesthetics		SUPPORT. The entire 5.3 mile reach is evaluated as supporting this use.

RECOMMENDATIONS (Saugus River MA93-35)

- The Massachusetts Surface Water Quality Standards lists this segment of the Saugus River incorrectly as a Class SB Waterbody suitable for Shellfishing. This designation should be changed in the next revision of the SWQS to a Class B warm water fishery and the segment description should be Saugus River from the Canal which discharges into Hawkes Pond to the Saugus Iron Works in Saugus where the river becomes tidally influenced.
- The smelt spawning habitat in the Saugus River clearly has potential to support a much larger spawning run than existed in 1988 and 1990. DMF recommends that rubble from the former dam adjacent to the Henkel Corporation be altered to the extent that would allow smelt to pass above the third rapid. Whether or not those modifications have been implemented is unknown. Secondly, efforts to determine the causal factors of the decline in the smelt population are recommended prior to the initiation of an enhancement project (Chase 1992). Entrainment of larvae in the Saugus River Estuary at water intakes may also contribute to the problem. These factors are discussed in the Saugus River Estuary segment assessment in this report.
- Additional dry weather fecal coliform sampling is recommended in the Saugus River and its tributaries (including Bennetts Pond Brook) in the reach between and including Hawkes Brook and the Saugus River Iron Works to identify potential sources of contamination.
- Occasional turbidity was observed in the Saugus River near the Ironworks. Additional site investigations are warranted in this area to determine if there are any unpermitted point or nonpoint source discharges contributing to this problem.
- Information from the Saugus River Watershed Council indicates that the river is frequently dry downstream of the Hawkes Brook canal. The effects of the flow modification as it reduces habitat quality in this segment of the river warrants further investigation. At a minimum, attempts should be made to maximize flow in the Saugus River, particularly in the summer months.
- The non-native invasive species, purple loosestrife (*Lythrum salicaria*) was identified in the wetlands surrounding the Saugus River near Camp Nihan. Determine the extent of the distribution and implement control measures to reduce the spread of this species.

MILL RIVER (SEGMENT MA93-31)

Location: From headwaters in wetland north of Salem Street, Wakefield to confluence with Saugus River, Wakefield. Length/area: 2.0 river miles. Classification: Class B.

SEGMENT DESCRIPTION

Mill River originates just south of Salem Street in Wakefield and flows in a southerly direction until it passes under Route 129. Here the river flows in a generally easterly direction to its confluence with the Saugus River in Wakefield. As of 15 April 1997, a review of the Chapter 21E sites (hazardous waste sites) indicate several locations where minor spillage of petroleum or hazardous waste was reported. These includes the following release tracking numbers in this area: MA0027413, MA0033481, 30003949, 30012551, and 3-0004450.

WITHDRAWALS AND DISCHARGES

WMA:

1. Wakefield Water Department is registered (31830501) to withdraw 0.48 MGD from Crystal Lake.

NPDES:

1. MAG250965 the Wakefield Corporation discharge of non-contact cooling water to a tributary of Mill River called "Wakefield Brook" in their permit.
2. MA0002356 Wakefield Bearing Corp.
3. MA0034452 Spirit Inc.
4. MA0103004 Crystal Lake Water Treatment Plant, applied for a permit in May 1986.

USE ASSESSMENT

Aquatic Life

DEP DWM conducted water quality sampling at three stations in the Mill River (Appendix B, Figure B2). The most upstream station (MR02) was located just upstream of Route 129/Water Street Bridge. Sampling at this station was limited to one occasion, 9 September 1997. Two pipes were also discharging upstream of station MR02. The next downstream station (MR01) was sampled upstream of the Farm Street bridge. Sampling at this station was conducted four times between September 1997 and January 1998. Sampling was also conducted on three occasions between June 1997 and September 1997 in the Mill River approximately 50 feet upstream of its confluence with the Saugus River (MR03). The data sets are presented in Appendix B, Tables B3 and B4 of this assessment report.

- Dissolved oxygen measurements were collected on 8 occasions in 1997/1998. The DO ranged between 2.0 and 10.2 mg/L (20 – 72% saturation) with >60% of the measurements (both concentration and % saturation) below the SWQS. None of these measurements were pre-dawn and, therefore, do not represent worse-case conditions.
- On one occasion the pH was above the SWQS with a measurement of 9.1 SU. Conductivity measurements ranged between 416 in June 1997 and 1,109 μ S/cm in January 1998, elevated for a freshwater system.
- Suspended solids ranged between 1.2 and 29 mg/L. Visual turbidity and gray appearance of water column was noted on two occasions (DEP 1998d). Conductivity ranged from 416 to 1109 μ S/cm.
- Nutrient measurements were collected on 8 occasions in 1997/1998. Ammonia nitrogen levels were as low as 0.04 mg/L and as high as 0.34 mg/L, while all nitrate nitrogen concentrations were at or below 1.0 mg/L. Total phosphorus concentrations were as high as 0.21 mg/L and as low as 0.03 mg/L.

DEP DWM and DEM made stream discharge measurements in the Mill River on seven occasions between June 1997 and January 1998 approximately 50 feet upstream of its confluence with the Saugus River (Appendix B, Table B2).

- Discharge was measured by both agencies on 9 September 1997 (0.70 cfs measured by DEM at 11:30 and 0.48 cfs measured by DEP at 13:30). Discharge measurements ranged from a low of 0.14 cfs in October 1997 to a high of 6.22 cfs in January 1998. Three measurements exceeded one cfs (June, October 1997, and January 1998).

Because of the low dissolved oxygen and slightly elevated nutrient concentrations, the *Aquatic Life Use* is assessed as non-support for this entire segment.

Recreation

DEP DWM conducted fecal coliform monitoring in two discharge pipes (MRP1 and MRP2) and at three stations in the Mill River (upstream to downstream -- MR02, MR01 and MR03). The complete data sets are presented in Appendix B, Table B5 of this assessment report.

- Fecal coliform bacteria levels in the two discharge pipes were elevated (1,300 cfu/100 mL in MRP1 and 1,500 cfu/100 mL in MRP2).
- The sample collected at MR02, downstream of these pipes, was 40 cfu/100 mL. Whether or not the effects of the pipe discharges (which were both located on the western bank of Mill River) were captured in the MR02 (collected mid-stream) sample is unknown.
- Fecal coliform bacteria levels in the Mill River at MR01 ranged between 100 and 600 cfu/100mLs and near the mouth of Mill River (MR03) the fecal coliform bacteria levels were between 60 and 420 cfu/100 mL.

The *Primary Contact Recreational Use* is evaluated with fecal coliform bacteria data collected between April 1 and October 15 (the primary contact recreational season). One sample collected from Mill River under dry weather sampling conditions within this time period exceeded 400 cfu/100 ml (use assessment guidance criterion) therefore the *Primary Contact Recreational Use* is assessed as non-support. Evidence of fecal coliform contamination from upstream discharge pipes (MRP1 and MRP2) further corroborates this evaluation. None of the instream fecal coliform bacteria levels exceeded 2,000 cfu/100 mL (Appendix B, Table B5). The *Secondary Contact Recreational Use* is however assessed as partial support because of the poor aesthetic quality (turbidity) noted during two of the water quality surveys.

Aesthetics

Visual turbidity and gray appearance of water column was noted by DEP DWM from the June and July 1997 surveys (DEP 1998d). These conditions impair (partial support) the *Aesthetics Use* for the entire length of the Mill River.

SUMMARY

Due to the frequency of low dissolved oxygen and/or saturation levels in the Mill River, the *Aquatic Life Use* is evaluated as non-support for the entire segment. The *Primary Contact Recreational Use* is assessed as non-support based on elevated levels of bacteria. The *Secondary Contact Recreational* and *Aesthetics uses* are assessed as partial support due of the poor aesthetic quality (turbidity) in this segment.

Designated Uses

Status: Mill River (MA93-31)

Aquatic Life		NON-SUPPORT. Because of the frequency of low dissolved oxygen and/or saturation levels in the Mill River, the <i>Aquatic Life Use</i> is evaluated as non-support for the entire 2.0 mile length of the segment.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 2.0 mile length of this segment does not support this use because of elevated levels of fecal coliform bacteria.
Secondary Contact		PARTIAL SUPPORT. The entire 2.0 mile length of this segment is evaluated as partial support for this use due to the aesthetically objectionable appearance of the water column (turbidity).
Aesthetics		PARTIAL SUPPORT. The appearance of this stream on at least two sampling occasions was poor (appearing gray and turbid), therefore this use has been evaluated as partial support for the entire 2.0 mile length.

RECOMMENDATIONS (Mill River MA93-31)

- Truck washing activities from a local cement company have caused turbidity problems in Mill Brook. Identify if this problem still exists and if so implement BMPs to reduce the impacts to the Mill River.
- Conduct additional pH sampling in the Mill River to establish if the high pH measurement was an outlier or a frequent and prolonged condition.
- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).

Wakefield Water Department

1. Evaluate whether or not the Crystal Lake Water Treatment Plant should apply for coverage under the general permit or the NPDES individual permit should be reissued with appropriate limits/monitoring requirements.

Wakefield Corporation

1. The Wakefield Corporation has been requested to submit a toxicity testing evaluation (modified acute and chronic toxicity testing using *Ceriodaphnia dubia* and *Pimephales promelas*) to DEP. These tests have not yet been conducted by the facility. Identify when the tests are completed and evaluate the results.
2. Identify the discharge location of the Wakefield Corporation NPDES outfall.

HAWKES BROOK (SEGMENT MA93-32)

Location: Headwaters at the border of Lynn/Lynnfield to the outlet of Hawkes Pond, North Saugus.
Length/area: 2.6 river miles. Classification: Class A, Public Water Supply, ORW.

SEGMENT DESCRIPTION

The upper segment of Hawkes Brook is a Class A, Outstanding Resource Water that originates on the southwestern side of Bow Ridge at the municipal border between Lynn and Lynnfield. The brook flows in a northwesterly direction crossing under both Routes 129 and 128, past Willow Cemetery where it then loops west then south and crosses back under Route 128. The brook then parallels Route 128 flowing in a westerly direction where it then turns south and crosses under Salem Street (near Interchange 31 of Route 128) and flows into Hawkes Pond. The water level of Hawkes Pond was extremely low during the 1997/1998 survey due to dam repairs. This pond is assessed in the Lakes Section of this report.

WITHDRAWALS AND DISCHARGES

WMA:

1. Lynn Water and Sewer Commission (LWSC) is registered (31816302) to withdraw 8.93 MGD and permitted (9P31816302) to withdraw an additional 1.28 MGD for a total withdrawal of 10.21 MGD from six sources. The LWSC maintains and controls four ponds (Hawkes, Walden, Breeds and Birch) in the Hawkes Brook subwatershed for the purpose of supplying drinking water to the city of Lynn.

USE ASSESSMENT

Aquatic Life

DEP DWM conducted water quality monitoring on four occasions in 1997/1998 downstream of Salem Street (HB02) in Lynnfield. Repairs to the dam structure at the south end of Hawkes Pond were ongoing during the reconnaissance and survey work in this subwatershed. The effects of the construction activity as it relates to the typical flow regimes and water quality conditions in Hawkes Brook hinders the assessment of water quality conditions. The *Aquatic Life Use* is therefore not assessed for the reasons described above. The data DEP DWM collected (water quality and biological monitoring) are presented in Appendix B, Table B2-B5 and in Appendix C.

Streamflow measurements in Hawkes Brook were made on five occasions between June 1997 and November 1997 by DEP and DEM personnel (Appendix B, Table B2). Discharge measurements ranged from a low of 0.03 cfs in July 1997 to a high of 0.71 cfs in November 1997.

Recreation

DEP DWM conducted fecal coliform bacteria monitoring at one location (HB02) in Hawkes Brook downstream of Salem Street in Lynnfield (Appendix B, Table B5).

- Fecal coliform bacteria levels were elevated, ranging between 460 to 2,000 cfu/100 mL. The three samples collected during the primary recreation season all exceeded 400 cfu/100 mL and were representative of dry weather sampling conditions.

The *Primary Contact Recreational Use* is impaired (non-support) due to elevated fecal coliform bacteria levels while the *Secondary Contact Recreational Use* is assessed as support.

Aesthetics

DEP DWM identified the aesthetic quality in Hawkes Brook to be poor due to the presence of algal mats and turbidity, which may have been, at least in part, related to the flow regulation (Appendix C). This use is not assessed at this time due to the ongoing construction project.

SUMMARY

Due to the temporary reduction in flow, caused by the dam repair activities, the *Aquatic Life Use* is not assessed in this segment. Elevated levels of fecal coliform bacteria impair the *Primary Contact Recreational Use* while the Secondary Contact Recreational Use is supported for this segment of Hawkes Brook. Although nuisance algae were identified in this segment, the temporary nature of the construction project precludes the assessment of the *Aesthetics Use*.

Designated Uses		Status: Hawkes Brook (MA93-32)
Aquatic Life		NOT ASSESSED. This use is not assessed due to flow regime manipulations related to construction activities as well as water supply withdrawals.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 2.6 mile length of this segment does not support this use because of elevated levels of fecal coliform bacteria.
Secondary Contact		SUPPORT. This use is supported for the entire 2.6 mile length.
Drinking Water		The DEP Drinking Water Program (DWP) maintains current drinking water supply data.
Aesthetics		NOT ASSESSED. This use is not assessed due to flow regime manipulations related to construction activities as well as water supply withdrawals.

RECOMMENDATIONS (Hawkes Brook MA93-32)

- Move the section of fence that runs adjacent to Route 128 upstream of Salem Street in Lynnfield (behind the Mills residence) to avoid crossing Hawkes Brook thus preventing large branches and debris from collecting on the fence (Appendix C). This will reduce the impediment to flow and thereby reduce the flooding of the brook.
- Sample at multiple locations in this segment for fecal coliform bacteria during wet and dry weather conditions to establish the extent of the elevated levels.
- Investigate sources of fecal coliform bacteria inputs to this segment (illicit sewer connections, failing septic tanks, etc.).
- Once dam repairs are completed conduct water quality monitoring (DO during pre-dawn conditions) to establish if the low dissolved oxygen (Appendix B, Table B3) was a result of flow reduction.
- Reevaluate the aesthetic quality of Hawkes Brook and determine if the objectionable aesthetic conditions were associated with the dam repair/flow reduction.

Lynn Water and Sewer Commission

1. Identify how the Lynn Water and Sewer Commission manipulates water in this area. If increased streamflows could be achieved through changes in the water supply system incorporate into WMA permit.
2. Establish how the reservoirs are connected and is there a strategy in place that focuses on maintaining flow in Hawkes Brook. If possible incorporate these strategies into their WMA permit or registration.
3. To the extent compatible with the drinking water use, maximize the amount of flow into Hawkes Brook.

HAWKES BROOK (SEGMENT MA93-33)

Location: Outlet of Hawkes Pond, Saugus to the confluence with the Saugus River, Saugus.

Length/area: 1.1 river miles. Classification: Class B.

SEGMENT DESCRIPTION

The lower segment of Hawkes Brook is a Class B waterbody that flows in a southerly direction from the outlet of Hawkes Pond to its confluence with the Saugus River.

WITHDRAWALS AND DISCHARGES

None known.

USE ASSESSMENT

Aquatic Life

DEP DWM conducted water quality monitoring in Hawkes Brook (HB01) upstream of Spring Street in North Saugus (Appendix B, Figure B2). Sampling at this station was conducted on six occasions between 25 June 1997 and 1 January 1998. Repairs to the dam structure at the south end of Hawkes Pond were ongoing during the reconnaissance and survey work in this subwatershed. The effects of both the construction activity as it relates to the typical flow regimes and water quality conditions in Hawkes Brook and "flow regulation" resulting from the drinking water supply manipulation unfortunately hinders the assessment of water quality conditions in this segment of Hawkes Brook. The *Aquatic Life Use* is affected by "flow regulation" and is not assessed for reasons described above. The data DEP DWM collected are presented in Appendix B, Table B2- B4 and in Appendix C.

DEP and DEM personnel made streamflow measurements in this lower segment of Hawkes Brook on six occasions between June 1997 and January 1998 (Appendix C, Table B2). Streamflow measurements ranged from a low of 0.08 cfs in July 1997 to a high of 0.52 cfs in November 1997.

Recreation

DEP DWM conducted bacteria monitoring in Hawkes Brook (HB01) upstream of Spring Street in North Saugus on six occasions between 25 June 1997 and 1 January 1998 (Appendix B, Table B5).

- Fecal coliform bacteria levels in upstream reaches of Hawkes Brook upstream were elevated, ranging between <20 and 2,400 cfu/100 mL. The three samples collected during the primary recreation season all exceeded 400 cfu/100 mL and were representative of dry weather sampling conditions.

Both the *Primary* and *Secondary Contact Recreational Uses* are assessed as non-support due to elevated fecal coliform bacteria levels.

SUMMARY

Due to the temporary reduction in flow, because of dam repair activities, the *Aquatic Life Use* and *Aesthetics* uses are not assessed in this segment. Elevated levels of fecal coliform bacteria impair (non-support) the *Primary* and *Secondary Contact Recreational Uses*.

Designated Uses

Status: Hawkes Brook (MA93-33)

Aquatic Life		NOT ASSESSED. This use is not assessed due to flow regime manipulations related to construction activities as well as water supply withdrawals.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 1.1 mile length of this segment does not support this use because of elevated levels of fecal coliform bacteria.
Secondary Contact		NON-SUPPORT. The entire 1.1 mile length of this segment does not support this use because of elevated levels of fecal coliform bacteria.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Hawkes Brook MA93-33)

- Investigate sources of fecal coliform bacteria inputs to this segment (illicit sewer connections, failing septic tanks, etc). The potential existence of a "CSO" in this reach of Hawkes Brook (Tashiro *et al.*, 1991) warrants further investigation. Sample at multiple stations for fecal coliform bacteria during wet and dry weather conditions to establish the extent of the elevated levels.
- Once dam repairs are completed conduct water quality monitoring (during pre-dawn conditions) to establish if low dissolved oxygen exists.

Lynn Water and Sewer Commission

1. Identify how the Lynn Water and Sewer Commission manipulates water in this area. If increased streamflows could be achieved through changes in the water supply system incorporate into WMA permit.
2. Establish how the reservoirs are connected and is there a strategy in place, which focuses on maintaining flow in Hawkes Brook. If possible incorporate these strategies into their WMA permit or registration.

SAUGUS RIVER (SEGMENT MA93-14)

Location: From Saugus Iron Works to the mouth at Lynn Harbor, Lynn/Salem.
Length/area: 0.80 mi². Classification: Class SB, ORW.

SEGMENT DESCRIPTION

This is a Class SB estuary which starts just downstream of the Saugus Iron Works National Historic Site in Saugus. From Boston Street to the mouth, this segment is designated as an "Outstanding Resource Water" because it is part of the Rumney Marshes ACEC. This segment of the River meanders in a generally east/southeasterly direction, receives flow from Shute Brook and the Pines River, and eventually flows into Lynn Harbor. For the purpose of this report the mouth can be defined as an imaginary line drawn off of the Point of Pines, Revere north to the shoreline of the city of Lynn east of the General Edwards Bridge (Route 1A).

As of 15 April 1997, a review of the Chapter 21E sites (hazardous waste sites) indicate several locations where minor spillage of petroleum or hazardous waste was reported. These include the following release tracking numbers in this area;

3-0011942 Eastern Tool & Stamping Co.

*MAD9805207533-0001599 General Electric Landfill

*MAD0651645683-0001714 RESCO Landfill

*These two landfills are regulated by DEP's Bureau of Waste Site Cleanup and have been subject to landfill closure requirements. In 1997 both sites received approvals to further upgrade the closure of both sites to minimize contamination from leaching and erosion during 1997. The approvals included local Orders of Conditions, Landfill Closure Approvals, USACE 401 Permits and State 401 Water Quality Certificates.

DEP managed loan projects that should be improving water quality conditions in this segment include:
SRF- Lynn Water and Sewer Commission Summer Street and Cottage Street Sewer Separator Project
SRF- Lynn Water and Sewer Commission I/I Flow Reduction and Sewer System Rehabilitation Project (Western Interceptor)

WITHDRAWALS AND DISCHARGES

WMA:

1. Carr Leather Company, Lynn is registered (31816301) to withdraw 0.1 MGD from groundwater.

NPDES:

1. MA0100552 for the Lynn Water and Sewer Commission outfall #003, Summer wet weather CSO which discharges to the "Little River" Street portion (also referred to as Strawberry Brook) of the Saugus River located upstream of the Route 107 Bridge. The LWSC CSO facilities plan was approved by DEP on 11 October 1991. Lynn is under a court order to mitigate their CSOs. Dry weather discharges are prohibited.
2. MA0028193 The Refuse Energy Systems Company (RESCO). The facility is engaged in trash burning and power generation and became operational in September 1985. RESCO withdraws water from the Saugus River at their intake structure located just southeast of the Route 107 (Salem Turnpike) in East Saugus. The Saugus River also forms the municipal boundary between Saugus and Lynn. They discharge, via outfall 001, 60 MGD of once through non-contact cooling water. The permit limit for temperature at the outfall is 90°F max and at no time is the discharge to exceed a 20°F rise over the temperature of the intake. A pre and post-operational biological monitoring program was required to determine potential impacts associated with the facility's operation on the Saugus River. The pre-operational (one-year baseline) monitoring program was completed in 1984. Field sampling activities performed included ichthyoplankton tows, beach seining, otter trawls, and recording physical data within the river (salinity, temperature, and dissolved oxygen). The post-operative monitoring study began in June 1986 and continued through May 1988 repeating the pre-operative sampling program and the addition of field components to evaluate the potential impacts of the water withdrawal on the local fish community in the Saugus River. Entrainment of ichthyoplankton by the once-through river water cooling system and impingement of finfish on the traveling intake screens was also evaluated.

RESCO's NPDES permit states that the following actions are required to document intake velocity and evaluate intake design:

- Determine intake velocity at several tidal periods. Model and field test physical and operational changes to intake system that will result in reduced larval entrainment.
- The permittee shall use 1991 ichthyoplankton sampling data and other applicable sources to model RESCO entrainment on adult populations of smelt and winter flounder in the Saugus River.
- The permittee shall report on the results of all of the items mentioned above. The report shall be attached to the October 1991 DMR. If the data were to be judged to be inadequate, the program shall be repeated the following year.

3. MA0003905 General Electric Company, Lynn (GE Lynn) currently maintains 15 permitted discharge outfalls along the northern bank of the Saugus River from Route 107 (Western Avenue) and Route 1A (General Edwards Bridge) in Lynn. The discharges are summarized from west to east as follows:

- **001:** stormwater runoff from roof and yard drains
- ***003:** average flow of 0.55 MGD up to 95°F and daily maximum 1.4 MGD of 105°F of non-contact cooling water. (water supplied by city)
- ***005:** average flow of 0.55 MGD up to 95°F and daily maximum 1.4 MGD of 105°F of non-contact cooling water. (water supplied by city)
- ***007:** average flow of 0.024 MGD up to 90°F and emergency discharge from test cells of average flow of 0.3 MGD up to 95°F and daily maximum 1.0 MGD of 105°F of non-contact cooling water, stream condensate and storm water runoff

*Note: outfalls (003, 005 and 007) may discharge only under emergency system shutdowns, otherwise the discharges have been eliminated by the installation of closed loop systems.

- **010:** average flow of 5.36 MGD up to 85.2°F and daily maximum 7.18 MGD of 90°F of non-contact cooling water, stormwater runoff and floor drainage
- **014:** average flow of 27 MGD up to 90°F and daily maximum 45 MGD of 95°F of non-contact cooling water. (**salt water**)—this discharge is intermittent
- **018:** average flow of 35.6 MGD up to 90°F and daily maximum 35.6 MGD of 95°F of non-contact cooling water. (**salt water**)—from power generation equipment, boiler blowdown and steam condensate.
- **019:** average flow of 0.083 MGD up to 88.4°F and daily maximum not specified of 90°F of non-contact cooling water, steam condensate, floor drains, contact cooling water, boiler filter backwash, ion exchange regeneration and backwash, flash tank blowdown, and stormwater runoff from roof and yard drains.
- **020:** average flow of 16.9 MGD with no temperature limit of unused circulating water from power generation, non-contact cooling water from rotor test, steam condensate, stormwater runoff from roof and yard drains. (**salt water**)
- **027:** average flow of 0.3 MGD up to 85°F and daily maximum 0.83 MGD of 90°F of stormwater runoff from roof and yard drains, steam condensate, oil coolers, and floor drainage.
- **032:** stormwater runoff from aircraft engine fuel storage area
- ***028:** average flow of 0.0036 MGD up to 85°F and daily maximum 0.0048 MGD of 90°F of non-contact cooling water from industrial heat exchangers, stormwater runoff from roof and yard drains
- ***029:** average flow of 28.8 MGD up to 90°F and daily maximum 54.7 MGD of 95°F of non-contact cooling water from steam turbine test equipment and heat exchangers (**salt water**) most likely intermittent.
- ***030:** stormwater runoff from plant grounds
- ***031:** average flow of 0.762 MGD up to 90°F and daily maximum 2.2 MGD of 90°F of non-contact cooling water from aircraft engine test cells, cooling tower blowdown from compressor cooling system, wash waters from aircraft engine test cells and stormwater runoff from plant grounds.

*Note: Outfalls 028, 029, 030, and 031 discharge into a small salt marsh channel that empties into the Saugus River.

Additionally the GE Lynn NPDES permit states "the thermal plumes from the station shall: (a) not block zones of fish passage, (b) not interfere with spawning of indigenous populations, (c) not

change the balanced indigenous population of the receiving water, and (d) have minimum contact with surrounding shorelines”.

GE Lynn was required to develop a multi-year biomonitoring program, developed in conjunction with DMF, DEP, CZM and EPA, that at a minimum was to determine the following characteristics of intake water from the Saugus River:

- occurrence and abundance of species impinged and entrained,
- mortality of species impinged and entrained and
- determine resulting losses to local spawning stocks.

If the data revealed negative impacts to the Saugus River marine resources by the cooling water intake system, structural or operational modification to the intake system would be required. Incidences of fish mortality associated with the plumes or unusual numbers of fish impinged on the intake travelling screens were to be reported to the regulatory agencies.

The GE Lynn permit also required a storm water pollution prevention plan.

4. MA0004634 Eastern Tool and Stamping Co., Inc., Saugus discharge of non-contact cooling water from two outfalls 001 and 002 into a tidal channel tributary of the Saugus River. Permit expired November 1980.

USE ASSESSMENT

Aquatic Life

The Saugus River estuary is heavily influenced by three major NPDES facilities. These facilities are required in their permits to conduct thermal impact evaluations, impingement and entertainment studies and the development of a stormwater pollution prevention plan. The data from each facility are summarized below.

RESCO - Results of the sampling conducted to evaluate post-operational effects of the RESCO facility on the Saugus River are summarized as follows:

- The thermal discharge from the facility creates a heated plume where a 2°F isotherm will, during extreme low tides, occupy up to 24.1% of the cross sectional area of the Saugus River.
- Entrainment at the RESCO intake may affect a high percentage of larvae found in the Saugus River adjacent to the plant, a particular concern because of potential impacts to the local smelt and winter flounder populations. RESCO was required to conduct additional monitoring to delineate the vertical and horizontal distribution of smelt and flounder larvae at the RESCO intake and across the river adjacent to the plant to determine why entrainment results appeared to be higher for those species. This additional monitoring is summarized in a report entitled *Biological monitoring program Saugus River, Saugus Massachusetts: Additional post operational entrainment studies April, May 1991* (Marine Research Inc. 1991).
- RESCO received their NPDES permit in September 1991. The results of their additional monitoring study were released on 31 October 1991

GE LYNN

- The fact sheet of the 1993 GE Lynn permit states that ENSR (consulting firm) performed mathematical modeling to evaluate the temperature effects (both near and far field) to evaluate the cumulative temperature effect in the Saugus River considering all of the GE thermal discharges as well as the RESCO discharge (DEP 1999b). These models were then calibrated by data collected by the US Army Corps of Engineers. The fact sheet of the permit states that the results of the modeling studies indicate that during average heat load conditions, a relatively small amount of river surface and cross-sectional area would exceed 85°F for all outfalls during maximum summertime ambient temperature conditions. Under maximum heat load conditions at outfall 029, the area that may exceed 85°F is mostly confined to the salt marsh channel adjacent to the Saugus River. Under maximum load conditions, a small section of the main channel of the Saugus River may exceed 85°F.
- ENSR also included a biological impact analysis to evaluate the potential thermal effects on the biological community of the Saugus River (5 planktonic, 6 benthic, and 3 pelagic organisms). They concluded little potential for biological impacts associated with thermal discharges from outfalls 003, 005 and 018. Outfall 029 was also evaluated but not mentioned in the summary. Large-scale thermal effects were evaluated by determining the potential for impacts on fish migration in the Saugus River. Rainbow smelt and alewives were considered in the analysis. They concluded very little potential for thermal impacts on fish migration. Predicted temperatures during the season of the year that fish migrate are lower than those that might affect migration (DEP 1999b). They cite further evidence that DMF studies document spawning smelt in the upper river reaches so therefore it is apparently unaffected by the thermal discharges.
- GE Lynn submitted the results of an impingement and entrainment monitoring study at GE River Works facility in Lynn (Marine Research Inc. 1997). The report presents the results of a two-year (November 1994 through October 1996) sampling program to evaluate the impingement and entrainment at the GE Lynn power plant salt water intake. This study demonstrated that a large number of fish and invertebrates are subject to impingement at the salt-water intake to the GE Lynn power plant. While the GE Lynn plant employs a screen wash return system, which washes the impinged organisms off of the intake screen into a return sluiceway, the sluiceway currently "discharged into what appeared to be an enclosure just southeast of the screenhouse" (Marine Research Inc. 1997). Since no apparent escape mechanism was available from the enclosure, it is highly likely that the mortality rate approached 100%.
- Effects of the other two salt water intakes from the Saugus River by GE Lynn, as much as 45 MGD for non-contact cooling water associated with outfall 014 and as much as 54.7 MGD of non-contact cooling associated with outfall 029 are unknown/unevaluated at this time.
- GE has reported several oil sheen discharges following heavy rain events from two outfalls 007 and 010 in the last two years. GE is installing a centralized treatment system to provide enhanced oil/water separation prior to discharge of dry weather flows. The estimated completion date is March 1999. GE is also continuing a drain-lining program to prevent ground water infiltration into the facility storm drain lines.

The *Aquatic Life Use* in the Saugus River Estuary is evaluated as non-support for the following reasons:

- facilities are located on opposite shores of this segment,
- impingement reduction mechanisms for at least one of the GE salt water intakes did not return the organisms to the river,
- the potential for thermal barriers to passage/migration resulting from the cumulative effects of intakes and thermal discharges, and
- biocide residuals in the discharges (concentrations unknown).

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that area N26 in the Saugus River is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

Recreation

Investigative sampling was conducted by DEP Northeast Regional Office (NERO), Wilmington on 22 October 1997 during dry weather conditions.

- Fecal coliform bacteria counts (n=2) at Summer Street / Strawberry Brook outfall exceeded 2,000,000 cfu/100 mL. Additional samples taken during the summer of 1998 during dry weather conditions again indicated significant fecal contamination.

Observations at the outfall by the Saugus River Watershed Council during wet and dry weather conditions frequently report excessive bacterial counts (Saugus River Watershed Council 1994.)

The *Primary* and *Secondary Contact Recreational Uses* in this segment of the Saugus River are evaluated as non-support. Evidence of dry and wet weather discharges from the Lynn CSO, frequently reported sheens of oil from several of the GE Lynn stormwater outfalls, and data from the Saugus River Watershed Council were used in the evaluation.

Aesthetics

GE Lynn has reported several oil sheen discharges following heavy rain events from two outfalls 007 and 010 in 1996 and 1997 (DEP 1998e). Due to these conditions the *Aesthetics Use* is assessed as non-support.

SUMMARY

The cumulative impacts of the GE Lynn and RESCO facility salt water intakes and thermal discharges on the biota of the Saugus River are unknown. The *Aquatic Life Use* is evaluated as non-support for the following reasons; the facilities are located on opposite shores of this segment, impingement reduction mechanisms for at least one of the GE salt water intakes did not return the organisms to the river, the potential for thermal barriers to passage/migration resulting from the cumulative effects of intakes and thermal discharges, and biocide residuals in the discharges (concentrations unknown). The *Shellfishing Use* is non-support due to a DMF prohibition. The *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses in this segment are evaluated as non-support because of elevated levels of pathogens and aesthetic degradation.

Designated Uses

Status: Saugus River (MA93-14)

Aquatic Life		NON-SUPPORT. The entire 0.80 mi ² area is evaluated as non-support for this use due to impacts barriers to migration, thermal discharges, and impingement hazards.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 0.80 mi ² area is evaluated as non-support for this use because of elevated levels of pathogens and aesthetic degradation.
Secondary Contact		NON-SUPPORT. The entire 0.80 mi ² area is evaluated as non-support for this use because of elevated levels of pathogens and aesthetic degradation.
Shellfishing		NON-SUPPORT. The entire 0.80 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NON-SUPPORT. The entire 0.80 mi ² area is evaluated as non-support for this use. Surface oil sheens have frequently been reported from the GE Lynn facility stormwater discharge outfalls on several occasions.

RECOMMENDATIONS (Saugus River MA93-14)

- Sources of fecal coliform bacteria to the Saugus River estuary (including Shute Brook) should be identified and remediated.
- Smelt spawning habitat in Shute Brook is impacted by stormwater as well as pollution and sedimentation during dry weather conditions (Chase 1992). DMF recommended that sources of sediment and bacteria should be identified and controlled. Work with the North Coastal Watershed Team to conduct a clean-up of Shute Brook to remove trash.
- Assess the results of the ongoing loan projects mentioned above as to the improving of water quality conditions (reduction of bacteria, nutrient, toxic substance, and sediment loadings) through post implementation monitoring.

Power Companies

Two power companies (RESCO and GE Lynn) discharge to this segment of the Saugus River. Resco discharges once-through, non-contact cooling water. GE Lynn operates both closed loop and non-contact cooling water systems. Aquatic resources (fish, shellfish, etc.) within receiving waters may be susceptible to the impacts of these discharges. Additional monitoring should be implemented and results provided to the regulatory agencies to identify possible impacts. During the next permit review, additional data collection/monitoring should be required of the power plant. In general DEP DWM recommends that all power plant operators in the Commonwealth collect the following types of information.

1. Flow (cooling water use schematic, permit limits and location of intake(s) and discharge(s))
 2. Intake design (should include velocity across screens, mesh size, information as to the ability to rotate screens, mechanisms for removing impinged fish, fish return systems)
 3. Discharge (thermal limit, discharge structure design)
 4. Monitoring program (Discharge Monitoring Reports type and report frequency)
 5. Biological monitoring (description of any biological monitoring programs required by permit)
 6. Fish kill (description of any specific fish kill provisions included in permit)
 7. Hydrological monitoring
- The cumulative effects of the salt water intakes in the Saugus River by GE Lynn and RESCO merit further investigation. DMF recommends that remedial actions to reduce the entrainment of fish larvae from the RESCO intake be implemented. Such actions should include either structural modifications to the intake system or conversion to a closed-loop cooling system that does not withdraw any river water (Chase 1992).
 - Determine if the cumulative effects of thermal discharges from GE Lynn and RESCO present instream thermal barriers to fish passage and migration. A technical advisory committee should be formed to evaluate both thermal and physical barriers to migration.
 - Saugus River Watershed Council recommends a ΔT (change in temperature due to a discharge) requirement be added to all industrial permits discharging to the Saugus River.

RESCO

- The thermal discharge from the facility creates a heated plume where a 2°F isotherm will, during extreme low tides, occupy up to 24.1% of the cross sectional area of the Saugus River. Identify the location of this cross sectional area, since the discharge is through a diffuser pipe.
- Establish if the environmental agencies (DEP, DMF, EPA, CZM) have reviewed and/or commented on the results of the additional monitoring submitted by RESCO or made an evaluation requiring additional data collection, changes to the intake structure or determined that no further action was required.

GE Lynn

- Marine Research Inc. (1997) provided GE Lynn with some suggestion of changes that could be made at the power plant intake from the Saugus River to improve survival among the fishes and invertebrates impinged on the intake screens. Identify if any of these recommendations have been implemented.

RECOMMENDATIONS Continued (Saugus River MA93-14)

GE Lynn

- Identify and evaluate the effects of the other two salt-water intakes from the Saugus River by GE Lynn.
- Identify if GE Lynn has completed the installation of a centralized treatment system to provide enhanced oil/water separation prior to discharge of dry weather flows. GE Lynn is also continuing a drain-lining program to prevent ground water infiltration into the facility storm drain lines. Establish if the drain-lining program has been completed.
- The GE Lynn outfalls, particularly 029, appear to have the potential to cause violations of Class SB surface water quality standards. Alternative treatment systems or discharge locations should be considered, and if justified, required in the next NDPES permit.
- Outfall #020 has an average flow of 16.9 MGD with no temperature limit of circulating and non-contact cooling water. Saugus River Watershed Council recommends establishing a temperature limit on this outfall.

Lynn Water and Sewer Commission

1. The Lynn Water and Sewer Commission should institute a sampling program to determine and eliminate the sources of bacterial contamination emanating from the Summer Street Outfall.
2. The LWSC NPDES permit specifically states that dry weather discharges from the CSO outfalls are prohibited. Determine whether or not the fecal coliform contamination at the outfall is a result of "CSO" discharges to the culverted stream known as Strawberry Brook remains in question.

Eastern Tool & Stamping

1. Eastern Tool and Stamping Co., Inc. NPDES permit needs to be reissued including an updated status facility, effluent discharge volumes and discharge quality.
2. Identify the location of discharge points.
3. Unless already established, develop a Stormwater Pollution Prevention Plan and BMP.

PINES RIVER (SEGMENT MA93-15)

Location: Route 1, Revere/Saugus to mouth of Saugus River at Lynn Harbor, Saugus/Revere.
Length/area: 0.70 mi². Classification: Class SB, ORW.

SEGMENT DESCRIPTION

This is a Class SB estuary which has been defined as the segment from the Route 1 bridge, Revere/Saugus to the mouth at the Saugus River, Revere/Saugus. This segment is also designated as an ORW because it is included in the Rumney Marshes ACEC. This segment of the Pines River meanders generally to the east prior to joining the Saugus River. Together these rivers flow into Lynn Harbor off of Point of Pines, Revere.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0034045 The Refuse Energy Systems Company (RESCO) Saugus Landfill discharges stormwater runoff into an unnamed tributary of the Pines River.
2. MA0036897 GLEN-MOR Fuel Oil Co.
3. MA0033103 Holiday Fitness Center
4. MA0032671 Sports Oil Co.

USE ASSESSMENT

Aquatic Life

The RESCO Saugus Landfill NPDES permit required acute toxicity testing of the discharge on a quarterly basis. Copies of the toxicity testing reports have not been submitted for review, although the test results may have been reported on the DMR form.

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that shellfishing in areas N26.1, N26.3 and N26.6 is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

SUMMARY

No current data was available to assess the *Aquatic Life*, *Primary* and *Secondary Contact Recreational*, and *Aesthetics* uses in this segment. The *Shellfishing Use* is assessed as non-support due to a DMF prohibition.

Designated Uses		Status: Pines River (MA93-15)
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NOT ASSESSED.
Secondary Contact		NOT ASSESSED.
Shellfishing		NON-SUPPORT. The entire 0.7 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Pines River MA93-15)

- The toxicity testing reports from the RESCO landfill should be submitted to the DEP DWM for review. Whether or not acute toxicity testing should remain as part of the permit needs to be evaluated.
- RESCO Saugus Landfill NPDES permit required acute toxicity testing of the discharge on a quarterly basis. Copies of the toxicity testing reports have not been submitted to DEP DWM for review, although the test results may have been reported on their DMR form.
- The RESCO landfill has been capped. Evaluate post-implementation monitoring to document the effectiveness of the capping project.
- Biological monitoring in the Pines River was conducted between 1984-1986 as part of the RESCO power plant pre- and post-operational monitoring program. These data included ichthyoplankton tows, beach seining, otter trawls, and recording physical data within the river (salinity, temperature, and dissolved oxygen). This dataset should be evaluated prior to the design of new biological monitoring studies.

LYNN HARBOR (SEGMENT MA93-23)

Location: An imaginary line from Bass Point, Nahant to the corporate boundary between Revere and Winthrop at Shortbeach Creek excluding the Saugus River. Length/area: 6.67 mi². Classification: Class SB.

SEGMENT DESCRIPTION

This is a Class SB estuary. For the purpose of this report, the harbor is defined as the waters inside of an imaginary line drawn across Bass Point, Nahant to the corporate boundary between Revere and Winthrop at Shortbeach Creek. A review of the April 15, 1997 Chapter 21E site report indicates numerous locations and times within this segment where hazardous waste or petroleum spillage has occurred.

WITHDRAWALS AND DISCHARGES

NPDES:

1. MA0100552--The Lynn Water and Sewer Commission (LWSC) which serves the city of Lynn and the towns of Nahant, Swampscott, and Saugus is a secondary WWTP that became operational in January 1991. A new permit for the facility was drafted in August 1999. The facility discharges an average monthly flow of 25.8 and up to 75 MGD of treated municipal and industrial wastewater via outfall 001 to Lynn Harbor (or Broad Sound?). Of the 25.8 MGD total wastewater flow, 2.3 MGD is industrial. Flows in excess of 75 MGD discharge via outfall 002 (the short outfall) into Lynn Harbor.

LWSC also has three wet weather CSO outfalls which discharge into Lynn Harbor (outfalls 004—Market Street Overflow, and 005 Broad Street Overflow). The Washington Street Overflow #007 has been sealed. The LWSC CSO facilities plan was approved by DEP on 11 October 1991. Lynn is under a court order to mitigate their CSOs. Dry weather discharges are prohibited.

USE ASSESSMENT

Aquatic Life

Acute and chronic effluent toxicity testing results have been submitted to DEP DWM by the LWSC since 1992.

- Test results indicated acute toxicity to *Menidia beryllina* (silverside minnows) on only one occasion (October 1998 test event).
- The effluent has not been acutely toxic to *Mysidopsis bahia* (mysid shrimp).
- Chronic toxicity test results for *M. beryllina* ranged between 38 and 100% effluent, which all meet the CNOEC permit limit of 14.3% effluent. Chronic toxicity testing results for the *Arbacia punctulata* (sea urchin) fertilization test, however, are quite variable ranging from 4.6 to 100% effluent.
- Effluent total residual chlorine (TRC) levels have ranged between <0.01 to 1.3 mg/L, exceeding the permit limit of 0.06 mg/L in 41% of the samples maintained in the TOXTD database (Dallaire 1998). It should be noted however, that only one of the TRC measurements since January 1996 has exceeded the 0.06 mg/L maximum daily discharge permit limit. LWSC has been dechlorinating their discharge since 1997.

Recreation

MDC conducts fecal coliform bacteria monitoring at Revere Beach on a weekly basis during the summer months (June – August). A summary of MDC's 1997 fecal coliform bacteria sampling results is presented in Table 5.

Table 5. Metropolitan District Commission (MDC) fecal coliform bacteria data (cfu/100 mL) for Revere Beach, summer 1997.

Sample Date	Revere @ Oak Island St.	Revere @ Bath House	Revere @ Beach St.
18 June 1997	240	260	15
19 June 1997	70	40	30
25 June 1997	85	30	20
1 July 1997	470	15	45
9 July 1997	245	145	110
16 July 1997	140	90	115
23 July 1997	860	1120	1100
30 July 1997	55	50	10
6 August 1997	20	40	70
13 August 1997	40	45	<5
20 August 1997	20	10	90
27 August 1997	70	5	<5

Investigative sampling was conducted by DEP NERO on two occasions, 22 October 1997 representing dry weather conditions, and again on 26 August 1998 during a light rainstorm. Samples were collected by bucket drop into the outflow of the CSO culverts, if they were observed to be flowing. The LWSC NPDES permit specifically states that dry weather discharges from the CSO outfalls are prohibited. The DEP NERO results are summarized below.

- Fecal coliform bacteria counts at the Broad Street CSO (outfall #005) exceeded 10,000,000 cfu/100 (n=2 samples). The fecal coliform bacteria count from the sample collected in August 1998 was 94,000 cfu/100 mL. Field reconnaissance was also conducted on 19 March 1998 under moderate rainfall conditions. No flow was observed to be discharging at that time.
- Fecal coliform counts at the Market Street CSO (outfall # 004) collected on 22 October 1997 ranged between 14,000 and 17,000 cfu/100 mL (n=2 samples). The sample collected on 26 August 1998 under light rain conditions was 110,000 cfu/100 mL. Field reconnaissance was also conducted on 19 March 1998 under moderate rainfall conditions. This outfall was observed to be flowing with a visible oil sheen. Stormwater runoff appeared to be the contributing source of the oil sheen.

Since Revere Beach was "posted" by MDC (G&L Laboratories 1998) during the summer of 1998 due to elevated levels of fecal coliform bacteria, the *Primary Contact Recreational Use* has been assessed as non-support. It should be noted, however, that this assessment relates primarily to areas designated specifically for *Primary Contact Recreation*. It is highly likely that the deeper water portions of Lynn Harbor would meet criteria. The *Secondary Contact Recreational Use* is supported based on the MDC summer of 1997 fecal coliform data (Table 5).

Shellfishing

The DMF Shellfish Status Report of January 1999 indicates that area N26 in Lynn Harbor is prohibited (Churchill 1999). Based on this information the *Shellfishing Use* for this segment is assessed as non-support.

SUMMARY

The *Aquatic Life Use* is not assessed at this time due to too little current water quality data. The *Shellfishing Use* is non-support due to a DMF prohibition. Elevated fecal coliform bacteria levels impair (non-support) the *Primary Contact Recreational Use* while the *Secondary Contact Recreational Use* is supported. The *Aesthetics Use* is not assessed at this time.

Designated Uses		Status: Lynn Harbor (MA93-23)
Aquatic Life		NOT ASSESSED.
Fish Consumption		NOT ASSESSED.
Primary Contact		NON-SUPPORT. The entire 6.67 mi ² area does not support this use due to an MDC beach closing.
Secondary Contact		SUPPORT. The entire segment supports this use.
Shellfishing		NON-SUPPORT. The entire 6.67 mi ² area does not support this use (prohibited). For watershed-wide shellfish growing area data see Appendix F.
Aesthetics		NOT ASSESSED.

RECOMMENDATIONS (Lynn Harbor MA93-23)

- Evaluate the results of the ongoing 21 E clean-up efforts as they relate to the improving of water quality conditions (i.e., reduction of toxic substance loadings).

Lynn Water and Sewer Commission

- Upon the request of the facility, *Mysidopsis bahia* toxicity testing requirements could be eliminated from the LWSC permit since the *Menidia beryllina* (silverside minnows) test organisms appear to be more sensitive to their effluent.
- The LWSC should institute a sampling program to determine and eliminate the sources of bacterial contamination emanating from the Market and Broad Street outfalls. Determine whether or not the fecal coliform contamination at the Broad and Market Street CSO outfalls (004 and 005) is the result of "CSO" discharges or stormwater.
- Track the status of the LWSC administrative consent order to eliminate all CSOs.
- Determine if the LWSC submitted a plan to assess the bioaccumulation potential from the existing LWSC discharges 001 and 002. If the plan was submitted, determine if it was reviewed and approved by EPA and DEP and whether or not it was implemented in the summer of 1993 and again in the summer of 1996. If conducted, EPA and DEP should evaluate the results of the study and recommend any changes/limits/monitoring requirements for the NPDES permit.

LAKE/POND ASSESSMENTS

A total of 43 lakes, ponds or impoundments (the term "lakes" will hereafter be used to include all) have been assessed in the North Coastal Watershed. Thirty-one of the lakes are less than 50 acres in total surface area, and seven of those are less than 10 acres. The lakes surveyed in 1997 are located wholly or partly within 16 different communities. However, three communities (Gloucester, 28%, Saugus, 12%, and Lynn, 12%) contained more than half (52%) of the lakes. The total surface area of the North Coastal Watershed lakes is 2,415 acres. Of that total, 87%, or 2,100 acres, was assessed during the 1997 surveys. Designated water supplies (i.e., Class A) accounted for nearly half (45% or 952 acres) of the assessed acreage.

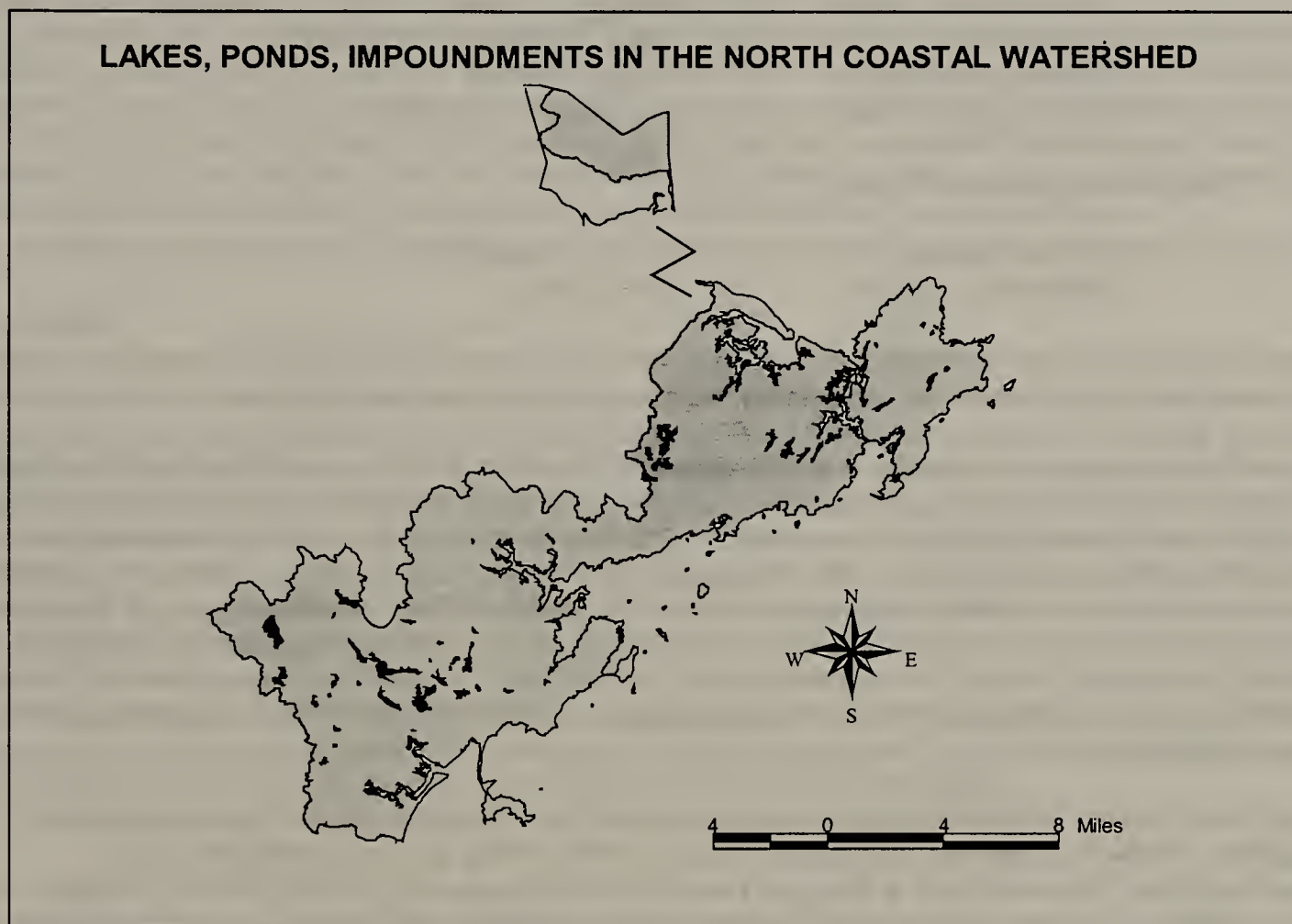


Figure 4. Location of lakes assessed in the North Coastal Watershed.

USE ASSESSMENTS

DEP DWM conducted synoptic lake surveys, during the summer of 1997, at a total of 43 lakes in the North Coastal Watershed. Surveys consisted of taking observations from at least one access point on each lake (multiple access points on larger lakes). At each lake, an attempt was made to observe the entire surface area to determine the extent of areal macrophyte cover. The trophic status of each lake was estimated and the presence of non-native aquatic and/or wetland plant species was also noted along with other objectionable conditions and potential threats to water quality (Appendix B, Table B8). The data gathered during these synoptic surveys, as well as MA DPH Fish Consumption Advisories (MA DPH 1998), were used to assess the status of the designated uses.

Aquatic Life

The *Aquatic Life Use* assessments for individual lakes are presented in Table 6. DEP surveys focused on the presence or absence of non-native macrophytes (Appendix B, Table B8). Lakes exhibiting impairment due to non-native macrophyte cover were noted as either partial or non-support. However, if a lake met these criteria it, or part of its area, was listed as not assessed because no dissolved oxygen data were available. Four non-native aquatic species and two non-native wetland species were observed in the North Coastal Watershed lakes, as follows.

Non-native Aquatic Plants

<i>Cabomba caroliniana</i>	Fanwort
<i>Egeria densa</i>	South American waterweed
<i>Eichornia crassipes</i>	Water hyacinth
<i>Potamogeton crispus</i>	Curly leaf pondweed

Non-native Wetland Plants

<i>Lythrum salicaria</i>	Purple loosestrife
<i>Phragmites australis</i>	Reed grass

Of the 43 lakes surveyed only eight, or 19% had a confirmed non-native aquatic macrophyte observed. In the case of wetland species, 39 lakes (91%), had non-natives associated with them.

Non-native plant species represent a special cause of impairment that is not always directly related to the cultural eutrophication process. Since these species are introduced from other parts of the country or world they are generally free from the natural control mechanisms (e.g., insects or diseases) that keep most native plant populations in check. Without controls the populations of many non-native species can grow rapidly to out-compete native plant species. This growth habit is termed invasive. It throws the biological community out of balance and can impair uses such as swimming (*Primary Contact*) and boating (*Secondary Contact*). In Massachusetts, the Division of Watershed Management is tracking the distribution of about a dozen of these non-native aquatic and wetland plant species and the impairment they are causing.

In the North Coastal Watershed none of the species of the non-native, aquatic plants were found frequently. Fanwort (*Cabomba caroliniana*) was observed in four ponds (Chebacco Lake in Essex/Hamilton, Griswold Pond in Saugus, Lower Pond in Saugus and Spring Pond in Saugus). Curly leaf pondweed (*Potamogeton crispus*) was also located in Chebacco Lake, but was also observed in Fiax Pond in Lynn and Lake Quannapowitt in Wakefield. Although there is good potential for these two invasive species to spread downstream, these waterbodies are either isolated from downstream flow or their discharge travels rather quickly to salt water without intersecting additional lakes.

The remaining two non-native aquatic plant species observed in the watershed, South American waterweed (*Egeria densa*) and water hyacinth (*Eichornia crassipes*) were recorded in only one pond each; the former in Days Pond, Gloucester, and the latter in Spring Pond, Lynn/Peabody/Salem. Neither of these species are likely to be an immediate threat to spread from their current locations. In the case of *Egeria densa* the outlet from Days Pond flows directly into an estuary where this species is not likely to survive. The water hyacinth is not a species that will overwinter successfully in this northern climate and so it presumably no longer exists at that sight, unless it was purposely reestablished.

Fish Consumption

In the summer of 1997 DEP DWM sampled 2 lakes in the North Coastal Watershed, Lake Quannapowitt in Wakefield and Chebacco Lake in Essex/Hamilton (Appendix B, Table B7). Fish toxics data indicated elevated levels of mercury in *Micropterus salmoides* (largemouth bass) from Lake Chebacco. Based on the data collected by DEP DWM's fish contaminant survey, MA DPH issued a P1-LMB, P3-LMB advisory for consumption of fish from Chebacco Lake and therefore the *Fish Consumption Use* is not supported. The P1, P3 advisory class states that "Children younger than 12 years, pregnant women, and nursing mothers should not consume any of the affected fish species (largemouth bass) from this waterbody" and that "the general public should limit consumption of largemouth bass to two meals per month".

The discovery of some largemouth bass in Chebacco Lake that have body burdens of mercury in excess of criteria established for consumption advisories is fairly consistent with findings from other waterbodies in Massachusetts as well as the entire Northeast. Largemouth bass are top level predators ranking high in the food chain. It has been recently discovered that even in the absence of identified point sources of mercury pollution, these top-level predators commonly possess elevated levels of mercury most likely a result of bioaccumulation. This discovery has led to a statewide health advisory warning that pregnant women should not consume fish from any inland Massachusetts waters, this advisory is not reflected in Table 6.

Primary and Secondary Contact Recreation and Aesthetics

DEP's lake synoptic surveys focused on three criteria: macrophyte cover, transparency, and biocommunity modifications (Appendix B, Table B8). Since macrophyte cover is the only criterion used to assess the *Secondary Contact Use*, this category was assessed at each lake surveyed. Lakes exhibiting impairment of the *Primary Contact Use* (swimmable) because of macrophyte cover and/or transparency were noted as either partial or non-support (see Use Assessment Methodology). However, if a lake met these criteria it, or part of its area, was listed as not assessed because no fecal coliform bacteria data were available. Recreation and Aesthetics use assessments for individual lakes are presented in Table 6.

SUMMARY

With the above qualifications for the overall assessment of lake resources in the North Coastal Watershed, the surveys indicated that the use of about 46 % of the surveyed surface acreage is impaired (Executive Summary, Table 1). Due to the focus of the surveys conducted, the major cause for use impairment was aquatic plants (either native or non-native). Turbidity was also noted occasionally as a cause. These causes may reflect symptoms of lake eutrophication, a process of enrichment from excessive plant nutrients and sediments being introduced to the lakes from cultural activities. This phenomenon is also reflected in the distribution of lake trophic conditions, which is skewed toward the more eutrophic categories.

The sources of impairment are largely unknown, at least based on direct knowledge. However, it can be surmised that nutrients delivered from storm water runoff and other non-point sources are likely to cause the increased algal or macrophyte productivity that has resulted in impairments.

Table 6. 1997 North Coastal Watershed Lake Assessments.

Lake Location	SIZE (Acres)	TROPHIC STATE	USE ATTAINMENT (Acres)	IMPAIRMENT CAUSE(S)
Babson Reservoir, ¹ Gloucester	29	U	2° Contact-S(29) Aesthetics-S(29)	No impairment noted
Beck Pond, Hamilton	40	E	2° Contact-S(40) Aesthetics-S(40)	No impairment noted
Birch Pond Reservoir, ¹ Lynn/ Saugus	80	U	2° Contact-S(80) Aesthetics-S(80)	No impairment noted
Breeds Pond ¹ Lynn	177	U	2° Contact-S(177) Aesthetics-S(177)	No impairment noted
Browns Pond ¹ Peabody	25	M	2° Contact-S(25) Aesthetics-S(25)	No impairment noted
Buswell Pond Gloucester	7	E	1° Contact-N(7) 2° Contact-N(7) Aesthetics-N(7)	Noxious plants
Cape Pond ¹ Rockport	41	E	1° Contact -P(41) 2° Contact-P(41) Aesthetics-P(41)	Turbidity
Chebacco Lake Hamilton/ Essex	204	E	Aquatic Life-P(204) Fish Consumption- N(204) 1° Contact-S(102);U(102) 2° Contact-S(102);N(102) Aesthetics-S(102);N(102)	Non-native plants (Cc, Pc), Noxious plants, Elevated levels if mercury
Cedar Pond Peabody	11	U	Aquatic Life-N(5);U(6) 1° Contact-N(5);U(6) 2° Contact-N(5);U(6) Aesthetics-N(5);U(6)	Non-native plants (Pa) Noxious plants
Coy Pond Wenham	25	E	1° Contact-N(25) 2° Contact-N(25) Aesthetics-N(25)	Noxious plants Turbidity
Crane River Pond Danvers	18	U	2° Contact-S(18) Aesthetics-S(18)	No impairment noted
Crystal Lake ¹ Wakefield/ Stoneham	80	M	1° Contact-P(80) 2° Contact-P(80) Aesthetics-P(80)	Noxious plants
Days Pond (Fugro East, Inc., '95) Gloucester	1	H	Aquatic Life-P(1) 1° Contact-N(1) 2° Contact-N(1) Aesthetics-N(1)	Non-native plants (Ed) Noxious plants (Fugro East, Inc., '95)
Fernwood Lake ¹ Gloucester	26	U	2° Contact-S(26) Aesthetics-S(26)	No impairment noted
Flax Pond Lynn	49	E	Aquatic Life-P(49) 1° Contact-P(34);N(15) 2° Contact-P(34);N(15) Aesthetics-P(34);N(15)	Non-native plants (Pc) Noxious plants Turbidity
Goose Cove Reservoir ¹ Gloucester	58	U	2° Contact-S(58) Aesthetics-S(58)	No impairment noted
Gravelly Pond ¹ Hamilton	46	U	2° Contact-S(46) Aesthetics-S(46)	No impairment noted
Griswold Pond ² (First Lake) Saugus	13	E	Aquatic Life-P(13) 1° Contact-N(13) 2° Contact-N(13) Aesthetics-N(13)	Non-native plants (Cc) Noxious plants

¹ Class A (water supply) waterbody; all others are Class B.² Outstanding Resource Water (ORW); Area of Critical Environmental Concern (ACEC).

Trophic Status M= Mesotrophic, E= Eutrophic, H= Hypereutrophic, U= Undetermined.

Use Attainment-- N= Non-support, P= Partial support, S= Full support, U= Undetermined.

Non-native Plants-- Cc= *Cabomba caroliniana*, Ed= *Egeria densa*, Pa= *Phragmites australis*, Pc= *Potamogeton crispus*.

Table 6. (Continued) 1997 North Coastal Watershed Lake Assessments.

Lake Location	SIZE (Acres)	TROPHIC STATE	USE ATTAINMENT (Acres)	IMPAIRMENT CAUSE(S)
Haskell Pond ¹ Gloucester	48	U	2° Contact-S(48) Aesthetics-S(48)	No impairment noted
Hawkes Pond ¹ Lynnfield/ Saugus	73	E	1° Contact-P(73) 2° Contact-P(73) Aesthetics-P(73)	Turbidity
Lily Pond Gloucester	31	H	1° Contact-P(3);N(28) 2° Contact-P(3);N(28) Aesthetics-P(3);N(28)	Noxious plants Turbidity
Lower Pond (Pearce Lake) Saugus	19	E	Aquatic Life-P(19) 2° Contact-S(19) Aesthetics-S(19)	Non-native plants (Cc)
Mill Pond Gloucester	21	U	2° Contact-S(21) Aesthetics-S(21)	No impairment noted
Niles Pond Gloucester	35	E	1° Contact-N(18);U(17) 2° Contact-S(17);N(18) Aesthetics-S(17);N(18)	Noxious plants
Pillings Pond Lynnfield	96	E	1° Contact-P(96) 2° Contact- P(96) Aesthetics- P(96)	Turbidity
Porters Pond Danvers	20	U	2° Contact-S(20) Aesthetics-S(20)	No impairment noted
Lake Quannapowitt Wakefield	250	E	Aquatic Life-P(250) 1° Contact-P(250) 2° Contact-P(250) Aesthetics-P(250)	Non-native plants (Pc) Turbidity
Quarry Reservoir ¹ Rockport	5	U	2° Contact-S(5) Aesthetics-S(5)	No impairment noted
Round Pond Hamilton	37	U	2° Contact-S(37) Aesthetics-S(37)	No impairment noted
Rum Rock Lake Rockport	9	U	2° Contact-S(9) Aesthetics-S(9)	No impairment noted
Seaplane Basin Revere	53	U	2° Contact-S(53) Aesthetics-S(53)	No impairment noted
Shoe Pond Beverly	8	E	1° Contact-P(8) 2° Contact-P(8) Aesthetics-P(8)	Turbidity
Sluice Pond Lynn	39	E	2° Contact-S(39) Aesthetics-S(39)	No impairment noted
Spring Pond ² Saugus	9	H	Aquatic Life-P(9) 1° Contact-N(9) 2° Contact-N(9) Aesthetics-N(9)	Non-native plants (Cc) Noxious plants
Spring Pond Lynn/ Peabody/ Salem	59	M	2° Contact-S(59) Aesthetics-S(59)	Non-native plants ³ (Ec)
Spring Pond (Upper) ** Peabody	10	E	1° Contact-N(10) 2° Contact-N(10) Aesthetics-N(10)	Noxious plants
Strangman Pond Gloucester	3	H	1° Contact-N(3) 2° Contact-N(3) Aesthetics-N(3)	Noxious plants Turbidity

² Outstanding Resource Water (ORW); Area of Critical Environmental Concern (ACEC).

Trophic Status M= Mesotrophic, E= Eutrophic, H= Hypereutrophic, U= Undetermined.

Use Attainment-- N= Non-support, P= Partial support, S= Full support, U= Undetermined.

Non-native Plants-- Cc= *Cabomba caroliniana*, Ec= *Eichornia crassipes*, Pc= *Potamogeton crispus*.

Table 6. (Continued) 1997 North Coastal Watershed Lake Assessments.

Lake Location	SIZE (Acres)	TROPHIC STATE	USE ATTAINMENT (Acres)	IMPAIRMENT CAUSE(S)
Upper Banjo Pond Gloucester	11	E	1° Contact-N(11) 2° Contact-N(11) Aesthetics-N(11)	Noxious plants Turbidity
Upper Pond (Silver Lake) Saugus	13	M	2° Contact-S(13) Aesthetics-S(13)	No impairment noted
Walden Pond ** Lynn/ Lynnfield/ Saugus	231	U	2° Contact-S(231) Aesthetics-S(231)	No impairment noted
Wallace Pond ** Gloucester	23	U	2° Contact-S(23) Aesthetics-S(23)	No impairment noted
Waters River Pond Danvers	57	U	2° Contact-S(57) Aesthetics-S(57)	No impairment noted

¹ Class A (water supply) waterbody; all others are Class B.

² Outstanding Resource Water (ORW); Area of Critical Environmental Concern (ACEC).

Trophic Status M= Mesotrophic, E= Eutrophic, H= Hypereutrophic, U= Undetermined.

Use Attainment-- N= Non-support, P= Partial support, S= Full support, U= Undetermined.

RECOMMENDATIONS

- For non-native aquatic or wetland plant species that were isolated to one or a few location(s) (*Cabomba caroliniana*, *Egeria densa* and *Phragmites australis*) quick action is advisable to manage these populations in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from these recorded locations, to determine the extent of the infestation. And, "spot" treatments should be undertaken to control populations at these sites before they spread further. These treatments may be in the form of carefully hand pulling individual plants, in small areas, or selective herbicide applications in larger areas. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These cautions will minimize the spreading of the populations.
- The wetland species *Lythrum salicaria* has become more wide-spread in the North Coastal Watershed lakes and wetlands. Accordingly, this species will require an extensive program aimed at 1) determining the extent of the distribution, 2) reducing impairment, and 3) controlling further spreading to unaffected waterbodies.
- As with the isolated cases, a program to manage the more extensive plant infestations should include additional monitoring efforts to determine the extent of the problem. Plant control aspects of any plan to manage the non-native aquatic species mentioned above can select from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.), each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should be discouraged because of the propensity for these plants to reproduce and spread vegetatively (from cuttings).
- Another important component of a management plan is prevention of further spreading of these plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations occurring in unaffected areas and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert lake users to the problem and responsibility of spreading these species.

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APPENDIX A - DEP DWM QA/QC

Introduction

Quality Assurance/Quality Control (QA/QC) activities were conducted as part of the DEP DWM North Coastal Watershed Monitoring Survey in 1997/98. This QA/QC review was conducted to ensure that the collection and analysis of the monitoring data was of high quality. The 1997/98 monitoring data subjected to this QA/QC review includes the following: discrete water samples, fish tissue samples and *in-situ* water quality measurements. All discrete water sample and fish tissue monitoring data were reviewed independently by the Wall Experiment Station's (WES) Quality Assurance Program and the Division of Watershed Management's (DWM) Quality Assurance Officer and Assessment Coordinator. All *in-situ* water quality measurements were reviewed independently by DWM's Hydrolab® Instrument Coordinator and Database Manager. Data that fell outside established QA/QC acceptance criteria were investigated and may have been subject to censoring. This Quality Assurance/Quality Control appendix is divided into three sections: A.1 field and laboratory data objectives; A.2 QA/QC data; A.3 analytical methods.

A.1 Field and Laboratory QA/QC Objectives

Data collected by DWM in the 1997/98 North Coastal Watershed survey was subject to field and laboratory data quality objectives. Section A.1.1 outlines the field collection objectives and laboratory quality control for discrete water samples. Section A.1.2 includes fish tissue laboratory quality control methods and Section A.1.3 includes Hydrolab QA/QC procedures.

A.1.1 Discrete Water Sample Data

FIELD

The collection of discrete water sample analytes followed DWM Standard Operating Procedures ^(1,2). Four field collection quality control criteria were applied to the North Coastal Watershed 1997/98 discrete water sample data:

- 1.0 Sampling/Analysis Holding Time: Each analyte has a standard holding time that has been established to ensure sample/analysis integrity. Refer to DWM Standard Operating Procedure Table 1.0 CN# 1.1 ⁽²⁾ for a complete listing. If the standard holding time was exceeded, this objective is violated.
- 2.0 Quality Control Sample Frequency: At a minimum, one field blank and one replicate must be collected for every ten samples by any given sampling crew on any given date. If less than one quality control sample per 10 field samples was collected, this objective is violated.
- 3.0 Field Blank: Field blanks were prepared at the DWM Worcester Office. Reagent grade water was transported into the field where it was transferred into a sample container and fixed using the same method as its corresponding field sample. All blanks were submitted to WES laboratory "blind". If the field blanks were significantly different (>2 standard deviations ⁽⁹⁾) from the detection limit, this data quality objective is violated.
- 4.0 Field Replicate: Two independent samples were collected from the same location and as close as possible to the same time in the field. Both samples were submitted to WES laboratory "blind". In order for this data quality objective to be met, the results must be:

$<20\%$ Relative Percent Difference (RPD) for method detection limits $>1\text{mg/L}$
 $<30\%$ RPD for method detection limits $<1\text{mg/L}$

A detailed QA/QC summary of the four data quality objectives and additional DWM quality assurance observations for the 1997/98 North Coastal Watershed data can be found in the 1997/98 Watershed QA/QC Assessment Report ⁽⁸⁾.

LABORATORY

Discrete water sample analysis followed EPA-approved laboratory QA/QC methodologies in accordance with WES Standard Operating Procedures⁽³⁾. The quality of data generated at WES was determined by analyzing the results of a variety of quality control procedures including but not limited to:

Low Calibration Standards – Checks the stability of the instrument's calibration curve. Analyzes the accuracy of an instrument's calibration within a 5% range.

Reference Standards – Generally, a second source standard (a standard different from the calibration stock standard) that analyzes the accuracy of an instrument's calibration within a 5% range.

Laboratory Reagent Blank/Method Blank (LRB) – Reagent grade water (de-ionized) extracted with every sample set to ensure that the system is free of target analytes (< MDL).

Duplicate Sample – Measures the precision (% Relative Percent Difference) of the extraction and analytical process. The acceptable laboratory %RPD range is typically $\leq 25\%$.

Spike Sample (Laboratory Fortified Blank - LFB, Laboratory Fortified Matrix - LFM)– Measures the accuracy (% Recovery) of an analytical method. The acceptable laboratory % recovery range is typically between 80 – 120% for LFB samples and 70 – 130% for LFM discrete water samples.

The WES Laboratory is solely responsible for the administration of its Quality Assurance Program and Standard Operating Procedures. The frequency of the laboratory's quality control procedure was at times inconsistent with their Quality Assurance Plan⁽³⁾. In these circumstances additional quality assurance procedures were used. Refer to WES's Quality Assurance Plan⁽³⁾ for specific laboratory analytical QA/QC criteria. WES laboratory releases discrete water sample data when their established QA/QC criteria are met or the data are labeled as outside of these criteria.

A.1.2 Fish Tissue Data

Fish were collected and processed according to DWM's Quality Assurance Project Plan⁽⁴⁾. Tissue preparation and analysis strictly adhered to EPA-approved laboratory QA/QC methodologies in accordance with WES Standard Operating Procedures^(6,7). The quality of tissue data generated at WES was determined by incorporating a variety of quality control samples:

Laboratory Reagent Blank/Method Blank (LRB) – Clean clam tissue matrix extracted with every sample set to ensure that the extraction and analytical process is free of target analytes (< MDL).

Laboratory Fortified Blank (LFB) – Clean clam tissue matrix spiked with a low concentration of target compounds. LFB results are used to establish accuracy of the extraction and analytical process. The acceptable laboratory % recovery range is typically 80 – 120%.

Laboratory Fortified Matrix (LFM) – Tissue matrix spiked with a low concentration of a target compound. LFM results are used to establish accuracy of the extraction and analytical process. The acceptable laboratory % recovery range is typically between 70 – 130% for metal analysis and 60 – 140% for PCB/Organochlorine Pesticide analysis.

Quality Control Standard (QCS) – A pre-spiked secondary tissue sample. QCS results are used to establish accuracy in the extraction and test methods. The acceptable laboratory % recovery range is typically between 80–120%.

The WES Laboratory is solely responsible for the administration of its Quality Assurance Program and Standard Operating Procedures. The frequency of the laboratory's quality control procedure was

at times inconsistent with their Quality Assurance Plan ⁽³⁾. In these circumstances additional quality assurance procedures were used. Refer to WES's Quality Assurance Plan ⁽³⁾ for specific laboratory analytical QA/QC criteria. WES laboratory releases tissue data when their established QA/QC criteria are met or the data are labeled as outside of these criteria.

A.1.3 *In-situ* Water Quality Analysis

Trained DWM staff members conducted *in-situ* measurements using a Hydrolab® Multiprobe Series 3 analyzer. The Hydrolab® Multiprobe Series 3 analyzer measures dissolved oxygen, temperature, pH, conductivity, depth and turbidity and calculates total dissolved solids and % saturation of oxygen. To ensure the quality of the *in-situ* data, the following QA/QC steps were taken:

- 1.0 Pre-Calibration: After each analytical probe on the Hydrolab® analyzer was calibrated, a pre-calibration check was conducted. A low ionic standard was first analyzed to check the accuracy of the instrument. Then an instrument check consisting of de-ionized water was analyzed to check the instrument for contamination. The instrument check criteria is based on de-ionized water that had been stored and vented to the air for at least three days. If the pre-calibration check achieved the criteria in Table A.1-1, then the instrument was ready for field analysis but if the pre-calibration check failed to achieve the low ionic standard criteria then the instrument was re-calibrated and a second low ionic and instrument check was analyzed. If the instrument failed to meet the established low ionic standard criteria a second time the Hydrolab® instrument could not be used to collect data and maintenance was scheduled. Refer to the DWM Hydrolab® Standard Operating Procedure ⁽⁵⁾.
- 2.0 Post Survey Check: Once the Hydrolab® was returned from field sampling, a post survey check was performed to ensure that no malfunction or damage had occurred to any of the Hydrolab® probes. The low ionic standard and the instrument check were re-analyzed. If the post survey check achieved the established criteria in Table A.1-1, the data was deemed acceptable and was ready for the data reduction QA/QC step. If, however, the post calibration failed to meet the criteria, the Hydrolab® Coordinator investigated the cause and recommended censoring of affected data to the Database Manager.
- 3.0 Data Reduction: The Hydrolab® Coordinator and Database Manager reviewed the Hydrolab® data for instability, instrument malfunction, operator technique and aberrant trends. If any of these conditions were detected, the data was investigated and may have been recommended for censoring. The Database Manager electronically tagged all data recommended for censoring in the database.

Table A.1-1. Hydrolab® Multiprobe Series 3 analyzer pre and post calibration specifications.

Hydrolab® Analyte	Low-Ionic Standard	Instrument Check *
Dissolved Oxygen	Saturation Chart (dependant on temperature & barometric pressure)	
pH	6.90 ±1%	5.6 ±0.2 units
Specific Conductance	74 ±1%	1.0 ±1%
Turbidity	0.0 ±5%	0.0 ±5%
Temperature	Ambient ±0.15°C**	Ambient ±0.15°C**
Depth	Field Calibrated ±0.45m	Field Calibrated ±0.45m
Salinity	Not Applicable	0.0 ±0.2ppt
Redox	Not Applicable	0.0±20mV

* Based on Division of Watershed Management's filtered de-ionized water

** Compared to the DWM laboratory's wall thermometer

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- (8) MA DEP. 1999. CN 9.0 1997/98 Watershed QA/QC Assessment Report, 1999. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.
- (9) Standard Methods for the Examination of Water and Wastewater, 20th Edition, Section 1010B "Statistics", pg. 1-2 and 1-3.

A.2 QA/QC DATA

Field blank and replicate sampling results for the discrete water quality sampling (physico/chemical and bacteriological) are provided in Tables A.2-1 through A.2-4. Tables A.2-5 and A.2-6 contain laboratory QA/QC data for organics in tissue analyses and metals in tissue analyses, respectively.

Table A.2-1. 1997/1998 DEP DWM North Coastal Watershed instream bacteriological QA/QC field blank data. (Units expressed in colonies/100ml.)

				Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
Field Blank Sample								
93-0012	BLANK	06/25/97	13:30		<20	--	--	--
93-0021	BLANK	06/30/97	13:45		<20	<20	--	--
93-0035	BLANK	07/29/97	13:30		<20	<20	--	--
93-0048	BLANK	07/29/97	15:44		<20	<20	--	--
93-0064	BLANK	09/09/97	13:15		<20	<20	--	--
93-0073	BLANK	09/09/97	14:10		<20	<20	--	--
93-0097	BLANK	10/21/97	**		<20	<20	--	--
93-0105	BLANK	10/21/97	13:21		<20	<20	--	--
93-0167	BLANK	11/19/97	**		**	--	--	--
93-0157	BLANK	11/19/97	11:14		<20	--	--	--
93-0207	BLANK	01/21/98	12:08		<20	<20	--	--
93-0217	BLANK	01/21/98	12:25		<20	<20	--	--
93-0253	BLANK	03/23/98	**		<20	<20	--	--

** = missing/censored data

-- = no data

Table A.2-2. 1997/1998 DEP DWM North Coastal Watershed instream bacteriological QA/QC field replicate data.
(Units expressed in colonies/100ml.)

				Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
CAT BROOK, Station: SM01								
93-0250	93-0251	03/23/98	8:18		<1.301	<1.301	--	--
93-0251	93-0250	03/23/98	8:18		<1.301	<1.301	--	--
Relative Percent Difference (RPD):					0.0%	0.0%		
FROST FISH BROOK, Station: PR01								
93-0092	93-0093	10/21/97	13:02		3.342	3.146	--	--
93-0093	93-0092	10/21/97	13:02		3.602	3.380	--	--
Relative Percent Difference (RPD):					7.5%	7.2%		
93-0162	93-0163	11/19/97	11:33		**	--	--	--
93-0163	93-0162	11/19/97	11:33		**	--	--	--
Relative Percent Difference (RPD):								
93-0212	93-0213	01/21/98	11:56		2.204	<1.301	--	--
93-0213	93-0212	01/21/98	11:56		1.301	<1.301	--	--
Relative Percent Difference (RPD):					51.5%	0.0%		
PROCTOR BROOK, Station: NR01								
93-0013	93-0014	06/30/97	14:25		3.041	2.806	--	--
93-0014	93-0013	06/30/97	14:25		3.079	2.833	--	--
Relative Percent Difference (RPD):					1.2%	0.9%		
93-0038	93-0039	07/29/97	15:26		4.505	3.778	--	--
93-0039	93-0038	07/29/97	15:26		4.699	3.477	--	--
Relative Percent Difference (RPD):					4.2%	8.3%		
93-0065	93-0066	09/09/97	11:52		3.176	2.663	--	--
93-0066	93-0065	09/09/97	11:52		3.176	2.792	--	--
Relative Percent Difference (RPD):					0.0%	4.8%		
SAUGUS RIVER, Station: SR01								
93-0001	93-0002	06/25/97	8:36		1.778	--	--	--
93-0002	93-0001	06/25/97	8:36		1.778	--	--	--
Relative Percent Difference (RPD):					0.0%			
93-0025	93-0026	07/29/97	8:45		2.792	2.079	--	--
93-0026	93-0025	07/29/97	8:45		2.748	2.000	--	--
Relative Percent Difference (RPD):					1.6%	3.9%		
93-0050	93-0051	09/09/97	7:17		3.447	3.114	--	--
93-0051	93-0050	09/09/97	7:17		3.322	3.079	--	--
Relative Percent Difference (RPD):					3.7%	1.1%		
93-0098	93-0099	10/21/97	10:41		3.079	2.301	--	--
93-0099	93-0098	10/21/97	10:41		2.778	2.146	--	--
Relative Percent Difference (RPD):					10.3%	7.0%		
93-0150	93-0151	11/19/97	9:44		3.230	--	--	--
93-0151	93-0150	11/19/97	9:54		2.934	--	--	--
Relative Percent Difference (RPD):					9.6%			
93-0200	93-0201	01/21/98	9:46		<1.301	<1.301	--	--
93-0201	93-0200	01/21/98	9:46		1.301	1.301	--	--
Relative Percent Difference (RPD):					0.0%	0.0%		

** = missing/censored data -- = no data

Table A.2-3. 1997/1998 DEP DWM North Coastal Watershed instream physico/chemical QA/QC field blank data. (All units expressed in mg/L unless otherwise specified.)

Field Blank Sample		Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
93-0012	BLANK 06/25/97	13:30	2.0	<0.66	--	<1.0	<2.5	--	--	--	<0.02	0.03	<0.01
93-0021	BLANK 06/30/97	13:45	2.0	<0.66	--	<1.0	<2.5	--	--	--	<0.02	<0.02	<0.01
93-0035	BLANK 07/29/97	13:30	3.0	<0.66	--	1.0	**	--	--	--	<0.02	<0.02	<0.01
93-0048	BLANK 07/29/97	15:44	1.0	<0.66	--	1.0	--	--	--	--	<0.02	<0.02	<0.01
93-0064	BLANK 09/09/97	13:15	3.0	<0.66	--	<1.0	<2.5	--	--	--	<0.02	<0.02	<0.01
93-0073	BLANK 09/09/97	14:10	3.0	<0.66	--	<1.0	<2.5	--	--	--	<0.02	<0.02	<0.01
93-0097	BLANK 10/21/97	**	2.0	<0.66	--	<1.0	<2.5	--	--	--	<0.02	<0.02	<0.01
93-0105	BLANK 10/21/97	13:21	2.0	<0.66	--	<1.0	<2.5	--	--	--	<0.02	<0.02	<0.01
93-0167	BLANK 11/19/97	**	**	**	--	**	**	--	--	--	**	**	**
93-0157	BLANK 11/19/97	11:14	1.0	<0.66	--	<1.0	**	--	--	--	<0.02	<0.02	**
93-0207	BLANK 01/21/98	12:08	<1.0	<0.66	--	<1.0	<1.0	--	--	--	<0.02	<0.02	<0.01
93-0217	BLANK 01/21/98	12:25	<1.0	<0.66	--	<1.0	<1.0	--	--	--	<0.02	<0.02	0.01
93-0253	BLANK 03/23/98	**	<1.0	<0.66	--	<1.0	<1.0	--	--	--	<0.02	<0.02	**

** = missing/censored data -- = no data

Table A.2-4. 1997/1998 DEP DWM North Coastal Watershed instream physico/chemical QA/QC field replicate data. (All units expressed in mg/L unless otherwise specified.)

CAT BROOK, Station: SM01		Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
93-0250	93-0251 03/23/98	8:18	4.0	18	--	6.3	<1.0	--	--	--	0.02	0.16	**
93-0251	93-0250 03/23/98	8:18	4.0	18	--	6.2	<1.0	--	--	--	<0.02	0.16	**
Relative Percent Difference (RPD):			0.0%	0.0%		1.6%	0.0%				0.0%	0.0%	
FROST FISH BROOK, Station: PR01		Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
93-0092	93-0093 10/21/97	13:02	73	348	--	651	<2.5	--	--	--	1.4	0.79	0.14
93-0093	93-0092 10/21/97	13:02	73	348	--	685	<2.5	--	--	--	1.4	0.75	0.13
Relative Percent Difference (RPD):			0.0%	0.0%		5.1%	0.0%				0.0%	5.2%	7.4%
93-0162	93-0163 11/19/97	11:33	**	**	--	**	**	--	--	--	**	**	**
93-0163	93-0162 11/19/97	11:33	**	**	--	**	**	--	--	--	**	**	**
Relative Percent Difference (RPD):													
93-0212	93-0213 01/21/98	11:56	37	95	--	255	<1.0	--	--	--	0.02	1.2	0.01
93-0213	93-0212 01/21/98	11:56	36	98	--	225	<1.0	--	--	--	0.02	1.2	0.02
Relative Percent Difference (RPD):			2.7%	3.1%		12.5%	0.0%				0.0%	0.0%	66.7%

** = missing/censored data -- = no data

Table A.2-4. Continued. 1997/1998 DEP DWM North Coastal Watershed instream physico/chemical QA/QC field replicate data. (All units expressed in mg/L unless otherwise specified.)

	Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
PROCTOR BROOK, Station: NR01												
93-0013	93-0014	06/30/97	14:25	70	117	--	--	--	--	0.10	1.2	0.06
93-0014	93-0013	06/30/97	14:25	64	118	--	--	--	--	0.11	1.3	0.07
<i>Relative Percent Difference (RPD):</i>												
93-0038	93-0039	07/29/97	15:26	86	123	--	--	--	--	0.11	1.7	0.13
93-0039	93-0038	07/29/97	15:26	86	128	--	--	--	--	0.11	1.7	0.14
<i>Relative Percent Difference (RPD):</i>												
93-0065	93-0066	09/09/97	11:52	80	126	--	--	--	--	0.07	1.3	0.06
93-0066	93-0065	09/09/97	11:52	80	125	--	--	--	--	0.06	1.2	0.06
<i>Relative Percent Difference (RPD):</i>												
				0.0%	0.8%	--	--	--	--	15.4%	8.0%	0.0%
SAUGUS RIVER, Station: SR01												
93-0001	93-0002	06/25/97	8:36	63	105	--	--	--	--	0.03	1.1	0.07
93-0002	93-0001	06/25/97	8:36	62	105	--	--	--	--	0.04	1.1	0.08
<i>Relative Percent Difference (RPD):</i>												
93-0025	93-0026	07/29/97	8:45	62	93	--	--	--	--	28.6%	0.99	0.06
93-0026	93-0025	07/29/97	8:45	63	95	--	--	--	--	<0.02	0.97	0.06
<i>Relative Percent Difference (RPD):</i>												
93-0050	93-0051	09/09/97	7:17	69	109	--	--	--	--	0.02	2.0%	0.0%
93-0051	93-0050	09/09/97	7:17	68	107	--	--	--	--	<0.02	0.83	0.04
<i>Relative Percent Difference (RPD):</i>												
93-0098	93-0099	10/21/97	10:41	69	138	--	--	--	--	<0.02	1.2%	28.6%
93-0099	93-0098	10/21/97	10:41	70	138	--	--	--	--	<0.02	0.52	0.03
<i>Relative Percent Difference (RPD):</i>												
93-0150	93-0151	11/19/97	9:44	50	99	--	--	--	--	0.0%	1.9%	0.0%
93-0151	93-0150	11/19/97	9:54	51	100	--	--	--	--	0.10	0.73	**
<i>Relative Percent Difference (RPD):</i>												
93-0200	93-0201	01/21/98	9:46	42	90	--	--	--	--	0.09	0.73	**
93-0201	93-0200	01/21/98	9:46	40	92	--	--	--	--	10.5%	0.69	0.02
<i>Relative Percent Difference (RPD):</i>												
				4.9%	2.2%	--	--	--	--	0.06	0.68	0.03
						--	--	--	--	15.4%	1.5%	40.0%

** = missing/censored data -- = no data

Table A.2-5. 1997/1998 DEP DWM North Coastal Watershed laboratory QA/QC data for organics in tissue analyses. (Data expressed in µg/g wet weight unless otherwise noted.)

ANALYTE	ACCURACY				MINIMUM DETECTION LIMIT
	Blank #1 (12/22/98 - 2/25/99)	Laboratory Fortified Matrix #1 (12/29/98 - 2/25/99)			
% Lipid	0.15	0.07			
		EXPECTED	LFM	RECOVERY (%)	
PCB A1242	*	*	*	*	0.26
PCB A1254	*	*	*	*	0.37
PCB A1260	*	0.92	0.78	85	0.11
Chlordane	*	*	*	*	0.044
Toxaphene	*	*	*	*	0.11
a-BHC	*	*	*	*	0.017
b-BHC	*	*	*	*	0.014
Lindane	*	*	*	*	0.012
d-BHC	*	*	*	*	0.029
Hexachlorocyclopentadiene	*	*	*	*	0.0077
Trifluralin	*	*	*	*	0.0062
Hexachlorobenzene	*	*	*	*	0.0091
Heptachlor	*	*	*	*	0.013
Heptachlor Epoxide	*	*	*	*	0.013
Methoxychlor	*	*	*	*	1.07
DDD	*	*	*	*	0.010
DDE	*	*	*	*	0.014
DDT	*	*	*	*	0.013
Aldrin	*	*	*	*	0.0092

* not detected or the analytical result is at or below the established minimum detection limit (MDL)

REMARKS: The samples were extracted and analyzed according to the modified AOAC 983.21 procedure for the analysis of PCBs and Organochlorine Pesticides.

LFM - laboratory fortified matrix

LFB - laboratory fortified blank

Table A.2-6. 1997/1998 DEP DWM North Coastal Watershed laboratory QA/QC data for metals in tissue analyses. (Data expressed in mg/kg wet weight unless otherwise noted.)

Sample ID	Analyte	Precision			Accuracy			Accuracy* (% Recovery)		MDL	Analytical Method
		Sample	Duplicate	RPD	LFM	Spike Amount	Recovery (%)	LFB	QCS		
L980381-5	As	<MDL	<MDL	NA	15.1	18.7	81	88	80	0.040	EPA 200.9
L980381-5	Se	0.208	0.213	2.4%	14.6	18.7	78	80	84	0.040	EPA 200.9
L980381-5	Hg	0.26	0.22	16.7%	0.01	0.0976	102	102	100	0.01	EPA 245.6
L980381-5	Pb	<MDL	<MDL	NA	20.6	18.7	110	110	101	0.14	EPA 200.7
L980381-5	Cd	<MDL	<MDL	NA	16.4	18.7	88	88	98	0.02	EPA 200.7

LFB - Laboratory Fortified Blank

LFM - Laboratory Fortified Matrix

MDL - Minimum Detection Limit

NA - Not Applicable

QCS - Quality Control Sample

RPD - Relative Percent Difference

*see Appendix A section A.1.2. for further details

A.3 Analytical Methods

<u>Discrete Water Sample Analytes</u>	<u>EPA Method*</u>	<u>SM Methods**</u>	<u>Other Methods</u>
Fecal Coliform		SM 9222D	
E. Coli, MTEC		SM 9213D	
Enterococci		SM 9230C	
Aeromonas Hydrophilia		SM 9260L	
Alkalinity (titrimetric)	EPA 310.1	SM 2320B	
Chloride (titrimetric)		SM 4500CLB	
Hardness (EDTA)	EPA 130.2	SM 2340B	
Turbidity	EPA 180.1	SM 2130B	
Specific Conductance (wheatstone bridge)	EPA 120.1	SM 2510B	
Ammonia-N (Automated – phenate)	EPA 350.1	SM 4500-NH ₃ -H	
Nitrate/Nitrite-N (automated – hydrazine)	EPA 353.1	SM 4500 –NO ₃ -H	
Total Kjeldahl Nitrogen (block digester)	EPA 351.2		
Total Phosphorus	EPA 365.2	SM 4500P-E	
OrthoPhosphorus	EPA 365.2	SM 4500P-E	
Suspended Solids		SM 2540D	
Biological Oxygen Demand (5 day)	EPA 405.1	SM 5210B	
Biological Oxygen Demand (multi-day)		SM 5210C	

Fish Tissue Analytes

PCB Arochlor 1242			AOAC 983.21***
PCB Arochlor 1254			"
PCB Arochlor 1260			"
Chlordane			"
Toxaphene			"
a-BHC			"
b-BHC			"
Lindane			"
d-BHC			"
Hexachlorocyclopentadiene			"
Trifluralin			"
Hexachlorobenzene			"
Heptachlor			"
Heptachlor Epoxide			"
Methoxychlor			"
DDD			"
DDE			"
DDT			"
Aldrin			"
Arsenic (STGFAA)	EPA 200.9	SM 3113	
Lead (ICP)	EPA 200.7	SM 3120B	
Selenium (STGFAA)	EPA 200.9	SM 3113	
Cadmium (ICP)	EPA 200.7	SM 3120B	
Mercury (cold vapor)	EPA 245.1	SM 3112B	

* = "Methods for Chemical Analysis of Water and Wastes", Environmental Protection Agency, Environmental Monitoring Systems Laboratory – Cincinnati (EMSL-CI), EPA-600/4-79-020, Revised March 1983 and 1979 where applicable.

** = Standard Methods, Examination of Water and Wastewater, 20th edition

***= PCBs and Organochlorine Pesticides in Biological Tissue, AOAC Official Methods of Analysis, 1990

APPENDIX B - 1997/1998 DEP DWM NORTH COASTAL WATERSHED SURVEY DATA

MATERIALS AND METHODS

The DWM began sampling in June 1997 and continued through March 1998. The DWM sampling plan matrix is summarized in Table B1. Sampling components at river stations included stream discharge, *in situ* measurements, physico-chemical and nutrient sampling, fecal coliform bacteria sampling, benthic macroinvertebrate sampling, and toxics in fish flesh. Synoptic surveys of lakes were conducted during August and early September 1997 to coincide with the maximum extent of macrophyte growth. Each sampling component is briefly described below.

Survey Conditions

Conditions prior to each survey were characterized by analyzing precipitation and streamflow data. Three weather station precipitation gages were used to determine precipitation and weather conditions in the five days prior to and on the sampling dates: Wakefield Station #706, South Essex Sewerage District Station #613, and Salem/Beverly Station #609. Data from these stations were provided by the DEM Office of Water Resources (MA DEM 1998). Discharge (hereinafter referred to as streamflow) and duration data were obtained from the only continuous USGS stream gage in the watershed (see Figure B1), Saugus River at Saugus Iron Works in Saugus (01102345). Data from this gage was used to calculate streamflow characteristics for the period of record. These statistical analyses can be found in *Water Resources Data Massachusetts and Rhode Island, Water Year 1997* (Socolow et al. 1998), *Water Resources Data Massachusetts and Rhode Island, Water Year 1998* (Socolow et al. 1999), and the *Gazetteer of Hydrologic Characteristics of Streams in Massachusetts—Coastal River Basins of the North Shore and Massachusetts Bay* (Wandle 1984). The period of record (POR) for the Saugus River gage is from March 1994 to present.



Figure B1. USGS gaging station location in the North Coastal Watershed.

Table B1. 1997 North Coastal Watershed Survey DEP DWM sampling matrix.

DRAINAGE SYSTEM	STREAMS SAMPLED	STATION	1997 JUNE	1997 JULY	1997 SEPT	1997 OCT	1997 NOV	1998 JAN	1998 MARCH
Annisquam River System	Alewite Brook	AL01	B, C, N, H						
SALEM SOUND Manchester Bay System	Sawmill Brook and Cat Brook	SM02		B, C, N, H					
		SM01	B, C, N, H, F*	B, C, N, H, QM, F*	B, C, N, H, F*	B, C, N, H, F*	B, C, N, H, F	B, C, N, H, F	
SALEM SOUND Beverly Harbor System	Bass River	BR01							B, C, N, H, F
		BR01P							
	Porter River System	PR01	B, C, N, H, F*	B, C, N, H, F*	B, C, N, H, F*	B, C, N, H, F*	B, C, N, H, F	B, C, N, H, F	
	Frost Fish Brook	FF01	H	B, C, N, H, M, P	H	H	H		B, C, N, H, F
	Unnamed trib to Frost Fish Brook	FF01a							B, C, N, H
	Crane River System	CR03	B, C, N, H, F	B, C, N, H, F	B, C, N, H, F				
SALEM SOUND	Beaver Brook	CR04		B, C, N, H, F	B, C, N, H				
	Crane Brook	CR02	B, C, N, H, F	B, C, N, H, F	B, C, N, H, F				B, C, N, H, F
	Crane River	CR01	B, C, N, H, F*	B, C, N, H, M, P, F*	B, C, N, H, F*	B, C, N, H, F*	B, C, N, H, F	B, C, N, H, F	
	Waters River	WA02		no flow					
SALEM SOUND		WA01	B, C, N, H, F*	B, C, N, H, F*, QM, P	B, C, N, H, F*	B, C, N, H, F*	B, C, N, H, F	B, C, N, H, F	
	North River System	NR01	B, C, N, H, F*	B, C, N, H, M, P, F*	B, C, N, H, F*	B, C, N, H, F*	B, C, N, H, F	B, C, N, H, F	
	Proctor Brook								
	Goldthwait Brook	GB01		P (collections near First Ave, Peabody)		no flow	B, C, N, H, F	B, C, N, H, F	B, C, N, H, F
SALEM SOUND	Salem Harbor Forest River	FR01	B, C, N, H, F*	B, C, N, H, F					

B=Bacteria (fecal coliform, E. coli); H=Hydrolab™ multiprobe meter (pH, dissolved oxygen, conductivity, temperature, total dissolved solids); N=Nutrients (total phosphorus, ammonia, nitrate-nitrogen, nitrite-nitrogen); C=Chemistry (alkalinity, hardness, chlorides, total suspended solids, turbidity); M=Macroinvertebrate sampling and habitat assessment; QM=Qualitative Macroinvertebrate Sampling (no multimetric analysis); P=Periphyton; F=Flow measurements by DEP-DWM, DEM*, or USGS**.

Table B1. Continued. 1997 North Coastal Watershed Survey DEP DWM sampling matrix.

DRAINAGE SYSTEM	STREAMS SAMPLED	STATION	1997 JUNE	1997 JULY	1997 SEPT	1997 OCT	1997 NOV	1998 JAN	1998 MARCH
Saugus River System	Saugus River	SR04	B, C, N, H, F	B, C, N, H, F					
		SR03	B, C, N, H, F	B, C, N, H, M, P, F**	B, C, N, H, F**	B, C, N, H, F**	B, C, N, H, F**	B, C, N, H, F**	
		SD01		B, C, N, H	B, C, N				
		SR02	B, C, N, H, F	B, C, N, H, F*, QM	B, C, N, H, F*	F*	B, C, N, H, F	B, C, N, H, F	
	Beaverdam Brook	SR01	B, C, N, H	B, C, N, H, M	B, C, N, H	B, C, N, H	B, C, N, H	B, C, N, H	
		BB01	B, C, N, H, F	B, C, N, H, F**	B, C, N, H, F**	B, C, N, H, F**	B, C, N, H, F**	B, C, N, H, F**	
		BB01A				B, H			
		MR03	B, C, N	B, C, N	B, C, N, H				
	Mill River	MR02		F**	B, C, N, H, F**, F**	F**	F**	F**	
		MRP1			B, C, N, H				
		MRP2			B, C, N, H				
		MR01	F			B, C, N, H	B, C, N, H	B, C, N, H	B, C, N, H
	Hawkes Brook	HB02	B, C, N, H, F	B, C, N, H, M, P, F**	B, C, N, H, F**	B, C, N, H, F**	F**		
		HB01	B, C, N, H, F	B, C, N, H, F**	B, C, N, H, F**	B, C, N, H, F**	B, C, N, H, F**	B, C, N, H, F**	

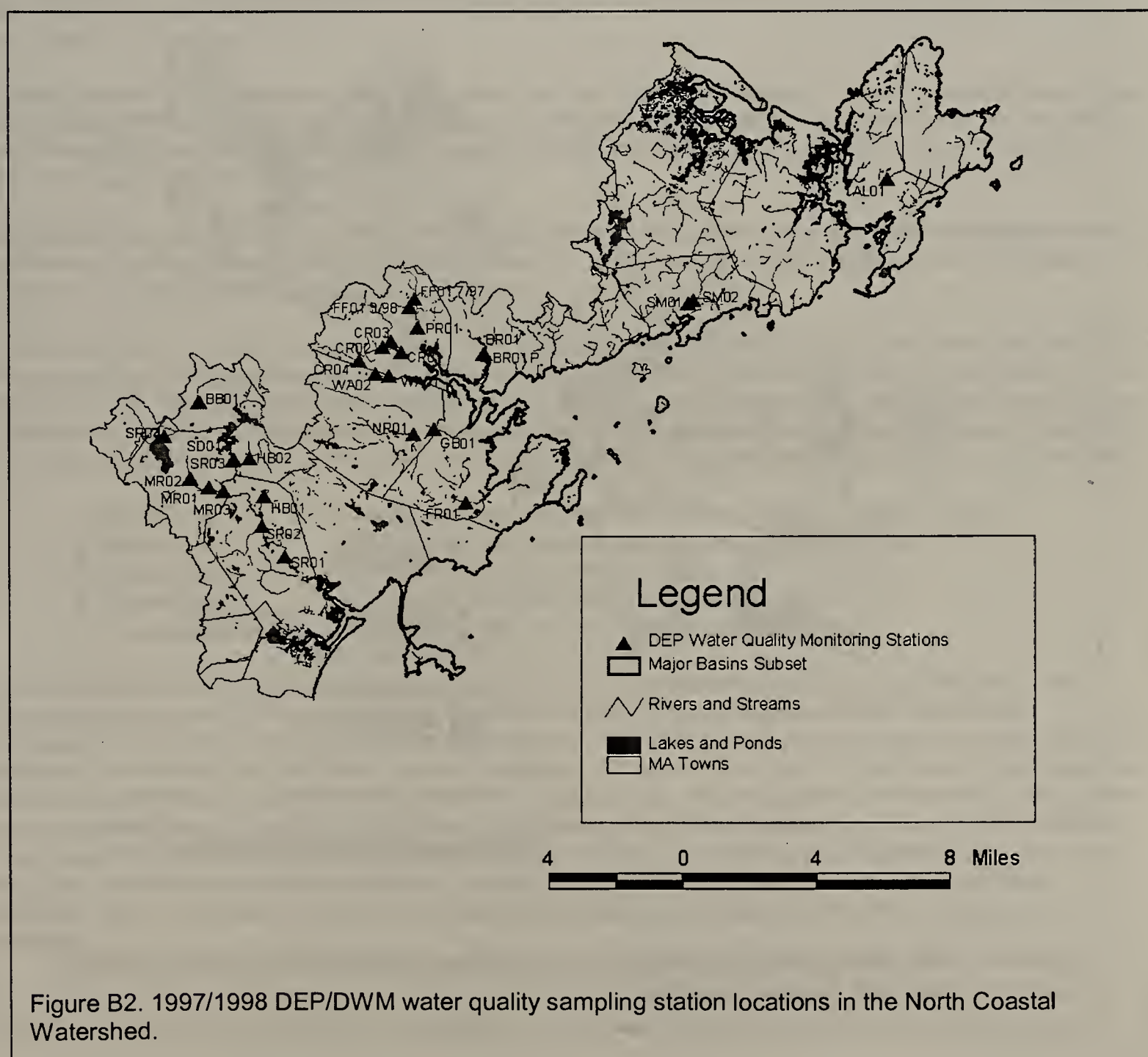
B=Bacteria (fecal coliform, E. coli); H=Hydrolab™ multiprobe meter (pH, dissolved oxygen, conductivity, temperature, total dissolved solids); N=Nutrients (total phosphorus, ammonia, nitrate-nitrogen, nitrite-nitrogen); C=Chemistry (alkalinity, hardness, chlorides, total suspended solids, turbidity); M=Macroinvertebrate sampling and habitat assessment; QM=Qualitative Macroinvertebrate Sampling (no multimetric analysis); P=Periphyton; F=Flow measurements by DEP-DWM, DEM*, or USGS**.

In addition to gage data, streamflow was measured at 17 additional stations in the North Coastal Watershed by either DEP-DWM personnel using a Swoffer meter (model 2100) according to standard operating procedures (TSB 1989) or DEM-ORW personnel, using a Price pygmy meter. Data reduction and stream discharge calculations were performed at either the DEP-DWM office in Worcester or at the DEM-ORW office in Boston.

To characterize survey conditions in the watershed, precipitation data from Wakefield Station #706, South Essex Sewerage District Station #613 and Salem/Beverly Station #609 (MA DEM 1998) along with streamflow data from the USGS Gage 01102345 Saugus Iron Works in Saugus (Socolow *et al.* 1998, and 1999) were analyzed.

Stream Water Quality Monitoring

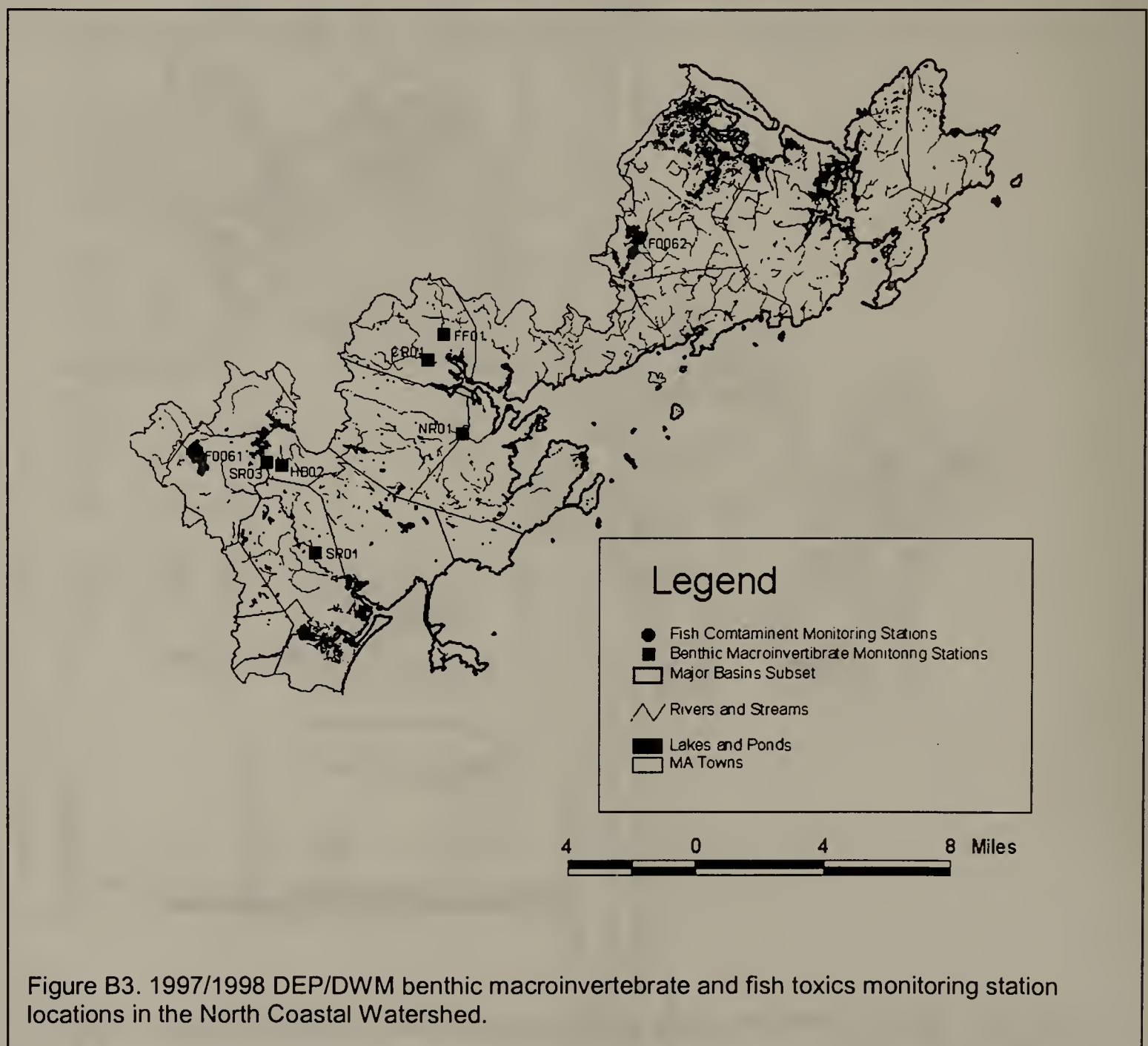
The water quality sampling effort was comprised of a baseline monitoring approach at the stations identified in Figure B2. Sampling at the baseline monitoring locations included: *in situ* measurements at each station using a Scout 2 Hydrolab™ multiparameter meter (water temperature, dissolved oxygen, conductivity, total dissolved solids, and pH), physico-chemical monitoring (alkalinity, hardness, specific conductivity, chloride, total and suspended solids, and turbidity), nutrients (ammonia and nitrate nitrogen and total phosphorus) and bacteria sampling (fecal coliform).



Procedures used for water sampling and sample handling are described in the *Basin Program Standard Operating Procedures* (MA DEP, 1989). The Wall Experiment Station (WES), the Department's analytical laboratory, supplied all sample bottles and field preservatives, which were prepared according to the *WES Laboratory Quality Assurance Plan and Standard Operating Procedures* (MA DEP 1994). Samples were preserved in the field as necessary, transported on ice to WES, and analyzed according to the WES SOP. The quality control protocol that was followed for field and equipment blank samples is described in Appendix A of this report. Both quality control samples (field blanks, trip blanks, and split samples) and raw water quality samples were transported on ice to WES on each sampling date; they were analyzed subsequently according to the WES SOP (MA DEP 1994).

Macroinvertebrates

Aquatic macroinvertebrates were collected from selected sites (see Figure B3) within the watershed by kick-sampling. Ten individual kicks taken within a 100 m reach of the selected stream were composited, representing a total sample area of 2 m². Collected material was transferred to a plastic jar, labeled, and preserved with denatured 95% ethanol. Habitat quality was scored at each sampling location following a habitat assessment procedure modified from Plafkin, *et al.* (1989). At sites where the kick-sampling methodology could not be applied a qualitative sample was collected by kicking bottom sediments, jabbing under banks, and sweeping through submergent and emergent vegetation.



Specimens were sorted from the sample debris using a randomized sub-sampling technique until a sub-sample containing 100 ± 10 organisms was obtained. Specimens were identified to family so that RBP II metrics (Plafkin *et al.* 1989) could be calculated. No sub-sorting was done for qualitative samples. Instead, specimens were removed from the sample only if they were different from what had already been removed, thereby giving an indication of the diversity within the sample. The complete DEP Biomonitoring Technical Memorandum is presented in Appendix C of this report.

Alewife Brook in Gloucester had been selected to serve as the reference for this watershed. At the time sampling was conducted (July 1997), however, there was no flowing water in its channel between its wetland headwaters and Babson Reservoir. Though not well suited to serve as reference sites because of the extent of development adjacent to, and upstream from them, the Frost Fish Brook site in Danvers (FF01) and the Saugus River site in Saugus (SR01) were selected to serve as the best alternative references.

Periphyton

During the summer of 1997, DEP/DWM personnel collected periphyton samples from a number of stations in the North Coastal Watershed. The sampling was conducted as part of the macroinvertebrate/habitat assessment. Samples were typically collected at least in the riffle zone and would usually be from scrapes of one substrate type. In the North Coastal Watershed, often both the riffle and the pools were sampled. Attached are a list of the taxa that were found at the different stations and a listing of abundance.

The objectives of the qualitative periphyton sampling were limited in scope. Primarily, the periphyton data was collected to help describe the benthic algal community and its habitat. The information is used along with the macroinvertebrate data and habitat data to help delineate impacted areas or areas in need of additional protection or remediation.

Sampling was done by DEP/DWM personnel and consisted of scraping rock and cobble substrates with a knife and collecting the material in a labeled glass vial. The samples were kept in an iced cooler and brought to DEP/DWM-Worcester for identification.

A vial was shaken to get a uniform sample before subsampling. If filamentous algae comprised most of the sample they were removed first, identified separately and then the remainder of the sample was examined. An Olympus BH2 compound microscope with Nomarski optics was used for the identifications.

Slides were typically examined under 200 power. A modified method for periphyton analysis developed by L. Bahls (1993) was used. The scheme developed by Bahls for determining abundance is as follows:

R (rare)	fewer than one cell per field of view at 200x, on the average;
C (common)	at least one, but fewer than five cells per field of view;
VC (very common)	between 5 and 25 cells per field;
A (abundant)	more than 25 cells per field, but countable;
VA (very abundant)	number of cells per field too numerous to count.

The periphyton work afforded a qualitative assessment of in-stream water quality and habitats. The information described above is critical for the determination of dominance in-stream. However, dominance alone does not provide all the information necessary to evaluate the impacts of algal growth on a stream. Information on the habitat and on the algal coverage is also helpful. Our current field collection methods do not include quantitative assessment of algal cover. Any indication of the extent of algal cover in a particular reach is based on an estimate made during the habitat assessment. Areas with extensive algal growth are certainly identified in this manner, but areas in transition may be overlooked. This does limit the usefulness of the data; therefore, the analysis is limited to general comments regarding a particular site. They may also take into account comparative observations with other streams and habitats.

During the summer of 1997 personnel from the Department deployed artificial substrates in some tributaries in the North Coastal Watershed in order to learn more about the productivity of the periphyton community. The quantitative assessment was based on the following formula:

$$P = \frac{\text{mg ash free weight/slide}}{tA}$$

where:

p=net productivity, mg ash free weight/m²/day

t=exposure time, days and

A=area of slide, m²

The recommended collection interval for the deployment of these artificial substrates is 2 to 4 weeks. We had them out for just under 3 weeks. In some places, the growth on them was prolific, so a longer time period might only have resulted in sloughing of algal material. One practice is to deploy the substrates over a period of a year, replacing some of the slides at each visit. Our sampling was a one-time effort so the gain in ash-free weight per unit area from one collection period to another, can not be evaluated. We also can not tell if we were out there during peak productivity. However, we can compare P values from station to station and also we can compare it to values from other river systems.

Periphyton samplers were composed of a wooden tray with slots to hold 8 glass or plastic slides. The trays were tied onto a cement block using nylon rope. The tray and block were put instream so that the slides were parallel to the flow; they were put into pools or runs and needed to be in water at least 8 inches deep to remain covered. When the slides were retrieved, the two outer slides were discarded. Two slides were randomly chosen for chlorophyll a analysis, three slides were air dried for determination of ash free dry weights and one slide was air dried for archiving. The slides were brought to the state laboratory, Wall Experiment Station, Lawrence for analysis of the ash free dry weights. The periphyton was removed from the glass slides by wetting the slide with a little deionized water and then scraping the surface with a razor blade. The scrapings were added to tared crucibles. They were dried to a constant weight at 105 °C; cooled in a desiccator and weighed. They were then ignited for one hour at 500 °C to get the ash free weight. The ash was then re-wetted and dried to a constant weight at 105 °C. This reintroduces water of hydration of clay and other minerals. The material that is volatilized represents the organic biomass that is converted to g/m². The ash-free weights from each slide are calculated separately and then averaged. Typically, two slide trays are deployed at each site and so the results from the two trays are averaged.

Fish Toxics

Uniform protocols, designed to assure accuracy and prevent cross-contamination of samples, were followed for collecting, processing and shipping fish collected for the fish toxics monitoring of Chebacco Lake in Essex/Hamilton and Lake Quannapowitt in Wakefield. Lake Quannapowitt was sampled with electrofishing gear on 18 May 1998. Fish were collected from Chebacco Lake on 3 June 1998 using electrofishing gear as well as gill nets. Lengths and weights were measured, and fish were visually inspected for tumors, lesions, or other indications of stress or disease. Fish included in the sample were placed in ice filled coolers and were brought back to DWM's laboratory in Worcester for sample processing. Sampling locations for fish toxics monitoring in the North Coastal Watershed are indicated in Figure B3.

Scale samples or pectoral spines were obtained from each sample to determine the approximate age of the fish. Fish were filleted (skin off) on glass cutting boards and prepared for freezing. All equipment used in the filleting process was rinsed in tap water to remove slime, scales, and other fluids such as blood, then re-rinsed in deionized water before (and/or after) each sample. Two to three fillets from like-sized individuals of the same species (composite sample) were wrapped together in aluminum foil or stored in the single sample container. Fillets targeted for metals analysis were placed in VWR 32 ounce high density polyethylene (DPDE) cups with covers. The opposite fillets were wrapped in aluminum foil for % lipids, PCBs and organochlorine pesticide analysis. Samples were tagged and frozen for subsequent delivery to WES.

Methods used at WES (MA DEP 1994) for analyzing metals include the cold vapor method using a VGA hydride generator for mercury and Varian 1475 flame atomic absorption for all remaining metals. PCB/organochlorine pesticides analyses were performed on a gas chromatograph equipped with an electron capture detector.

Lakes

A series of synoptic surveys were conducted on 43 lakes in the North Coastal Watershed during the summer of 1997. From the information gathered during these surveys, three types of assessments were made on these lakes. First, they were assessed against the criteria for use support from the "Summary of Water Quality Report" (MA DEP 1998). Next, the trophic status (level of nutrient enrichment) of each lake was evaluated. And last, the presence of non-native aquatic and/or wetland plant species was noted. Fish advisory information was obtained from the Department of Public Health.

Synoptic surveys consisted of taking observations from at least one access point on each lake (multiple access points on larger lakes). At each lake, an attempt was made to observe the entire surface area to determine the extent of areal macrophyte cover.

At each observation site the general water quality was noted and all aquatic and wetland macrophyte species were recorded along with their general abundance and an estimate of the total percent areal coverage of all species. Qualitative macrophyte observations were aided by conducting several hauls with a plant "rake," which was constructed by bolting two garden rakes back-to-back, the handles cut to about half length, and then attached to about a 50' length of rope. Each time the rake was thrown to its maximum extension and then retrieved along the lake bottom. The rake was thrown several times in different directions from the observation site to provide more thorough coverage.

Where possible, transparency was measured using a standard 20-centimeter diameter Secchi disc attached to a rope with metric calibrations. When Secchi disc measurements were not feasible, transparency was estimated as being above or below 1.2 meters (based on the 4 foot Secchi disc bathing beach standard).

All observations were recorded on standardized field sheets. Assessments of trophic status and use impairment were made on site. Later, the assessments and supporting information were entered into the US EPA Water Body System database. Data on the presence of non-native plants were entered into a separate database intended for linking to the Massachusetts Geographic Information System (MassGIS).

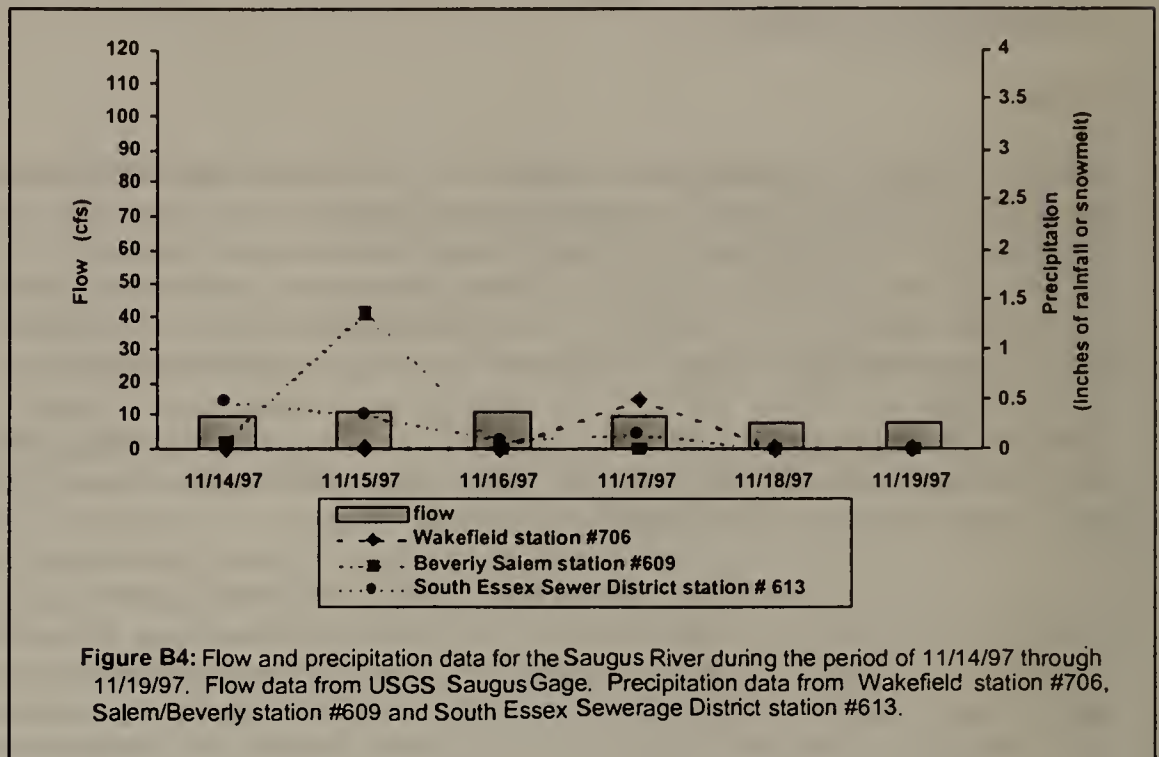
RESULTS AND DISCUSSION

Survey Conditions

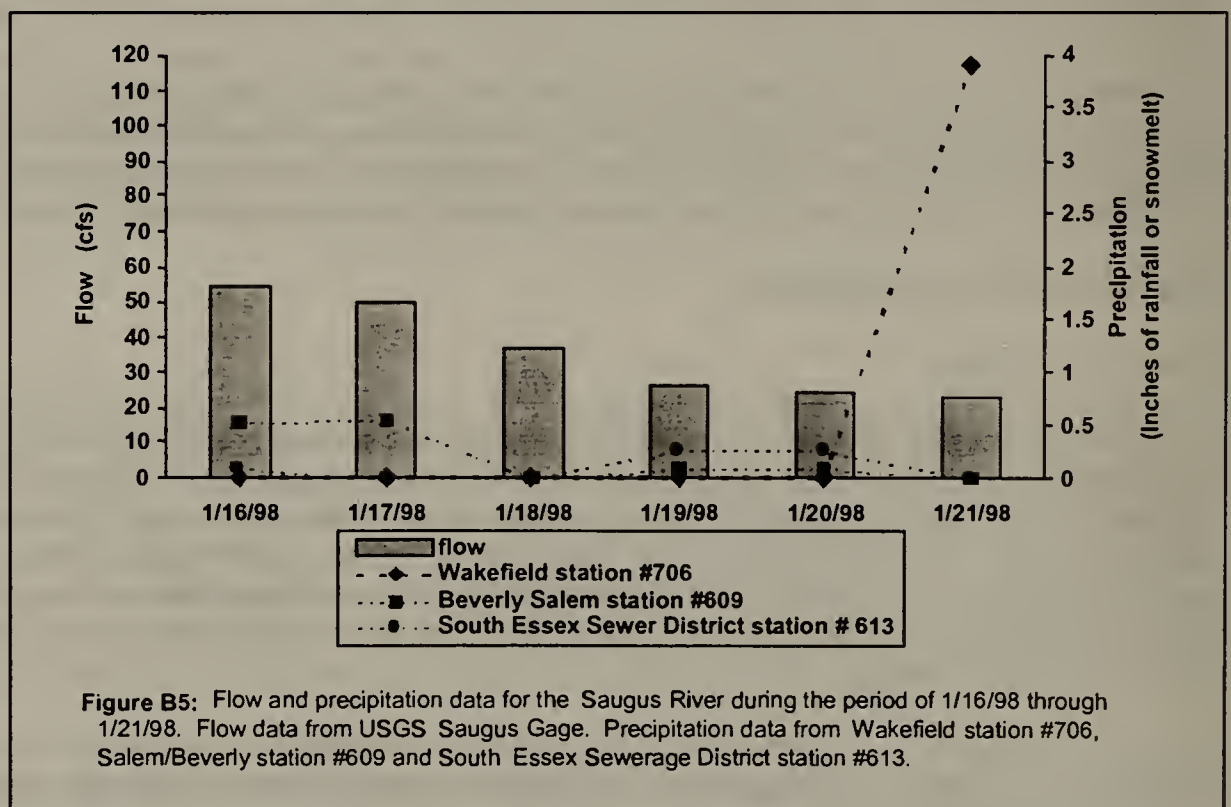
To fulfill the assessment guidance, information on precipitation (MA DEM 1998) and stream discharge (Socolow *et al.* 1998, and 1999) and stream discharge measurements Table B2 were analyzed to determine hydrologic conditions during the water quality sampling events. This review was conducted to determine the streamflow condition in relation to the 7-day, 10-year (7Q10) low flow. Additionally, this review was used to determine whether the fecal coliform bacteria data were representative of "wet" or "dry weather" sampling conditions. Survey conditions are described below for each DWM sampling event reviewed for the assessment.

The first five surveys performed during the summer and fall of 1997 occurred during and following relatively dry weather. Although some insignificant trace amounts of rain fell sporadically over the study areas preceding some of the surveys, little or no increase in flow resulted from the minor precipitation. Mean monthly discharge over the past five years for the months of June, July, September and October are 6.36 cfs, 4.72 cfs, 10.6 cfs and 48.0 cfs respectively. Flow rates during each of the survey dates was significantly lower than these averages. Therefore, results of the surveys performed on 6/25/97, 6/30/97, 7/29/97, 9/9/97, and 10/21/97 will be interpreted as being representative of dry weather conditions. The last three surveys in the series were subject to precipitation and fluctuating flow rates as follows:

19 November 1997 – An average of one inch of rain fell over the study area during the five-day period preceding the survey (MA DEM 1998). No rain, however, was reported the day before and the day of the survey. As illustrated in Figure B4 flow conditions recorded at the Saugus Iron Works Gage on the Saugus River (Socolow *et al.* 1999) ranged from a steady 11cfs on 11/15 and 11/16 (four and three days prior to the survey) then diminished to 7.6 cfs on the day of the survey. Although this slight augmentation in flow occurred a few days before the survey, the discharge is still well below 37.2 cfs, the mean monthly average flow for November over the past five years (Socolow *et al.* 1998). Therefore, any lingering effects of the precipitation are to be considered insignificant and the results of this survey should be evaluated with this in mind.



21 January 1998 – An average of about an inch of precipitation covered most of the North Coastal Watershed spanning the five days prior to this survey with the majority occurring four or five days preceding the actual sampling (MA DEM 1998). As illustrated in Figure B5, flow rates (Socolow *et al.* 1999) at the Saugus Iron Works Station gradually diminished from an estimated 31cfs five days before the survey to 23 cfs on the day of the survey. The five-year average discharge rate for January at this gage is 49.2 cfs and the three-year, annual daily average is 30.9 cfs (Socolow *et al.* 1998). The Saugus River sub-watershed drains approximately 23 square miles. Given this relatively small drainage area, precipitation events undoubtedly result in elevated flows but the swollen river conditions are most likely short lived. Although significant precipitation was recorded for the week prior to the survey and the river discharge was elevated for a few days, the conditions for most of the study area during the survey were probably reflective of streams and rivers approaching normal ambient flow situations.



23 March 1998 - Varying amounts of rain were recorded at least once at the three stations for each of the five days preceding this survey as well as the day of the survey. An average of 2.16 inches was recorded among the stations over the period (MA DEM 1998). As illustrated in Figure B6 flow at the Saugus Iron Works Station

(Socolow *et al.* 1999) increased steadily from 51 cfs on 3/18 to a peak of 116 cfs on 3/20. Flow diminished slightly over the next couple of days but remained at elevated levels hovering around 90 cfs through the survey date. The five-year mean flow (Socolow *et al.* 1998) for March at this station is 56.5 cfs, well below the discharge rate seen for the survey as

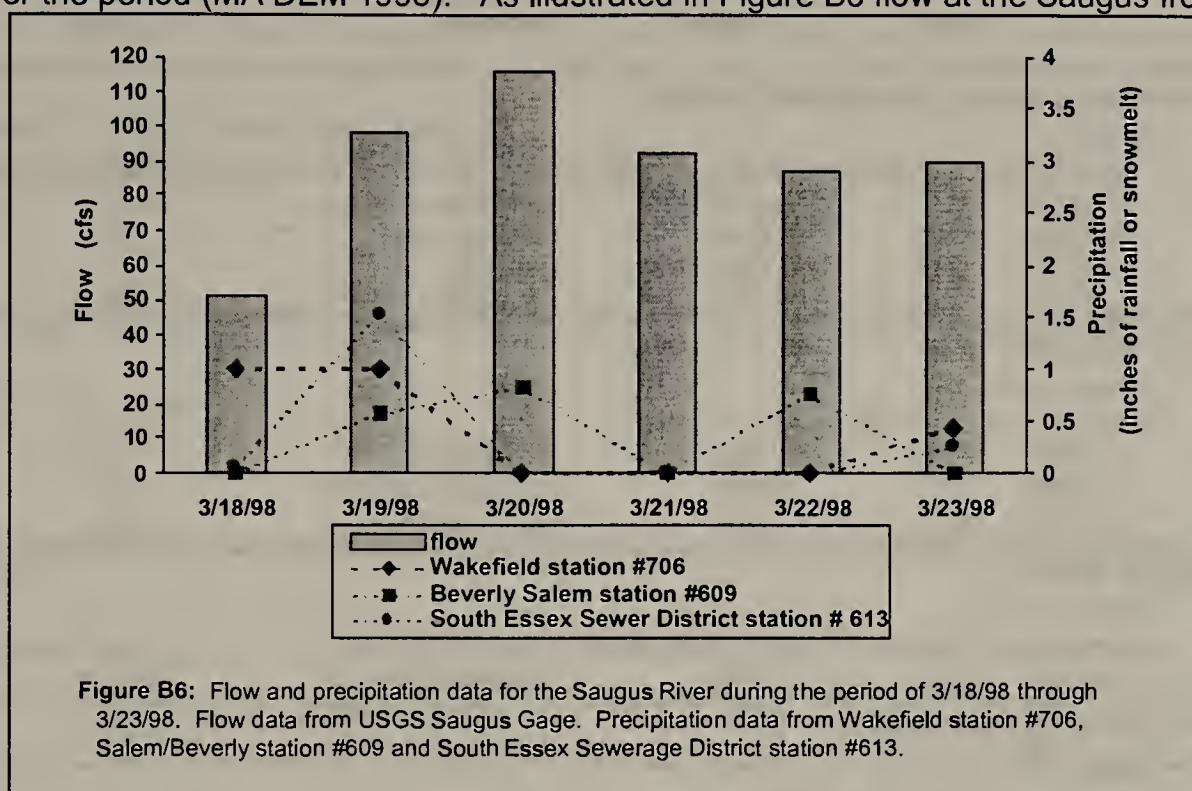


Figure B6: Flow and precipitation data for the Saugus River during the period of 3/18/98 through 3/23/98. Flow data from USGS Saugus Gage. Precipitation data from Wakefield station #706, Salem/Beverly station #609 and South Essex Sewerage District station #613.

well as the antecedent period. The data collected on 3/23 should be interpreted with caution given the prolonged duration of rainy weather prior to the survey, "first flush" conditions most desirable to indicate "run-off" sources of pollution were not achieved. Another factor to consider during winter months is ice formation and melting. Even during and after periods of precipitation, if ambient temperatures are low enough to maintain freezing conditions, any precipitation that does not fall directly into the stream will not contribute to increased flow until temperatures rise and melting occurs. Flow measurements Table B2 were calculated at the Waters River in Danvers by DWM staff at two intervals (9:00 and 16:00) during the day of the survey resulting in respective discharge rates of 1.86 cfs and 4.22 cfs, an increase of over 100% in only seven hours. This increase was attributed to snow-melt runoff.

Table B2. 1997/1998 DEP DWM North Coastal Watershed stream discharge measurements.

	Time (24hr)	Collecting Agency	Sampling Technique	Velocity (fps)	Discharge (cfs)
Unnamed and/or Undefined SARIS					
Station: ,					
Description: Lynn diversion canal, Lynnfield. (east of the Saugus River at footbridge crossing canal, near country club)					
07/29/97	**	DEM	Unknown	**	0.17
09/09/97	13:00	DEM	Unknown	**	0.13
10/21/97	9:45	DEM	Unknown	**	0.07
11/19/97	9:30	DEM	Unknown	**	8.80
CAT BROOK					
Station: SM01					
Description: at School Street, Manchester					
11/19/97	13:15	DEP	Swoffer 2100	0.84	5.78
01/21/98	12:40	DEP	Swoffer 2100	1.3	10.1
03/23/98	10:38	DEP	Swoffer 2100	1.8	19.3
BASS RIVER					
Station: BR01					
Description: at Route 62, Beverly. (downstream of Shoe Pond outlet)					
03/23/98	3:31	DEP	Swoffer 2100	0.26	9.99
FROST FISH BROOK					
Station: FF01					
Description: at Cabot Road, Danvers					
03/23/98	2:22	DEP	Swoffer 2100	1.2	4.84
FROST FISH BROOK					
Station: PR01					
Description: at Route 62, Danvers					
11/19/97	10:59	DEP	Swoffer 2100	0.59	1.89
01/21/98	11:20	DEP	Swoffer 2100	0.92	4.46
03/23/98	1:00	DEP	Swoffer 2100	1.2	8.96
CRANE RIVER					
Station: CR01					
Description: at Ash Street, Danvers					
11/19/97	11:51	DEP	Swoffer 2100	0.21	2.12
01/21/98	10:30	DEP	Swoffer 2100	0.46	6.17
03/23/98	11:50	DEP	Swoffer 2100	1.3	18.6
BEAVER BROOK					
Station: CR03					
Description: at Holten Street, Danvers					
06/25/97	13:35	DEP	Swoffer 2100	0.13	0.33
07/29/97	13:50	DEP	Swoffer 2100	0.17	0.11
09/09/97	10:12	DEP	Swoffer 2100	0.40	0.10
CRANE BROOK					
Station: CR02					
Description: at Pine Street, Danvers					
06/25/97	14:10	DEP	Swoffer 2100	0.24	0.69
07/29/97	12:35	DEP	Swoffer 2100	0.30	0.27
09/09/97	10:35	DEP	Swoffer 2100	0.13	0.38
CRANE BROOK					
Station: CR04					
Description: at Barron Chevrolet, Route 114 (Andover Street), Danvers					
07/29/97	11:05	DEP	Swoffer 2100	0.38	0.23
09/09/97	11:22	DEP	Swoffer 2100	0.59	0.35
03/23/98	11:02	DEP	Swoffer 2100	1.4	3.33

** = missing/censored data e = flow estimated see field sheet for details

Table B2. (Continued) 1997/1998 DEP DWM North Coastal Watershed stream discharge measurements.

Time (24hr)	Collecting Agency	Sampling Technique	Velocity (fps)	Discharge (cfs)
WATERS RIVER				
Station: WA01				
Description: behind "Linens & Things", Endicott Street, Danvers				
11/19/97 10:10	DEP	Swoffer 2100	0.04	0.16
01/21/98 9:40	DEP	Swoffer 2100	0.24	0.69
03/23/98 4:00	DEP	Swoffer 2100	0.61	4.22
03/23/98 9:00	DEP	Swoffer 2100	0.31	1.86 e
PROCTOR BROOK				
Station: NR01				
Description: at Howley Street, Peabody				
11/18/97 13:00	DEP	Swoffer 2100	0.55	2.96
01/21/98 15:00	DEP	Swoffer 2100	0.98	14.2
03/23/98 12:20	DEP	Swoffer 2100	1.5	39.5
GOLDTHWAIT BROOK				
Station: GB01				
Description: at Foster Street, Peabody				
11/18/97 12:06	DEP	Swoffer 2100	0.05	0.03 e
01/21/98 13:45	DEP	Swoffer 2100	0.57	5.29 e
03/23/98 11:37	DEP	Swoffer 2100	2.0	19.1
FOREST RIVER				
Station: FR01				
Description: approximately 0.4 miles west of Loring Avenue, Salem. Walk in from Harrison Road, Salem.				
03/23/98 2:47	DEP	Swoffer 2100	0.87	6.79
SAUGUS RIVER				
Station: SR02				
Description: at Route 1, North Saugus				
06/25/97 8:05	DEP	Swoffer 2100	0.14	1.59
11/18/97 11:00	DEP	Swoffer 2100	0.24	3.10
01/21/98 11:20	DEP	Swoffer 2100	1.3	17.0
SAUGUS RIVER				
Station: SR03				
Description: at Salem Street, Wakefield/Lynnfield				
06/25/97 11:40	DEP	Swoffer 2100	0.35	0.19
07/29/97 10:15	DEM	Unknown	**	0.12
09/09/97 8:35	DEM	Unknown	**	0.11
10/21/97 11:30	DEM	Unknown	**	0.14
11/19/97 **	DEM	Unknown	**	0.16
01/21/98 **	DEM	Unknown	**	5.79
SAUGUS RIVER				
Station: SR04				
Description: at Lowell Street, Wakefield. (downstream of Lake Quannapowitt outlet)				
06/25/97 12:20	DEP	Swoffer 2100	0.24	0.05 e
07/29/97 9:35	DEP	Swoffer 2100	0.11	0.02
HAWKES BROOK				
Station: HB01				
Description: at Spring Street, North Saugus. (downstream of Hawkes Pond)				
06/25/97 8:55	DEP	Swoffer 2100	0.13	0.05 e
01/21/98 **	DEM	Unknown	**	0.19

** = missing/censored data e = flow estimated see field sheet for details

Table B2. (Continued) 1997/1998 DEP DWM North Coastal Watershed stream discharge measurements.

Time (24hr)	Collecting Agency	Sampling Technique	Velocity (fps)	Discharge (cfs)
HAWKES BROOK				
Station: HB02				
Description: at Salem Street, Lynnfield				
06/25/97 10:40	DEP	Swoffer 2100	0.11	0.17
07/29/97 9:30	DEM	Unknown	0.59	0.03
09/09/97 10:00	DEM	Unknown	**	0.04
10/21/97 11:00	DEM	Unknown	**	0.07
11/19/97 11:00	DEM	Unknown	**	0.71
HAWKES BROOK				
Station:				
Description: at Camp Nihan access road bridge, Saugus. (approximately 50 feet downstream from double culvert)				
07/29/97 14:30	DEM	Unknown	**	0.08
09/09/97 11:00	DEM	Unknown	**	0.10
10/21/97 13:00	DEM	Unknown	**	0.48
11/19/97 11:00	DEM	Unknown	**	0.52
MILL RIVER				
Station: MR02				
Description: at Route 129, Wakefield (DEP/DEM) (near Expert Body Shop (DEP))				
07/29/97 12:00	DEM	Unknown	**	0.88
09/09/97 11:30	DEM	Unknown	**	0.70
09/09/97 13:23	DEP	Unknown	**	0.48 e
10/21/97 12:15	DEM	Unknown	**	0.14
11/19/97 **	DEM	Unknown	**	2.53
01/21/98 **	DEM	Unknown	**	6.22
MILL RIVER				
Station: MR01				
Description: south of Route 129 near Wakefield/Saugus border, approximately 50 feet upstream of confluence with the Saugus River				
06/25/97 9:55	DEP	Swoffer 2100	0.24	1.24
BEAVERDAM BROOK				
Station: BB01				
Description: at Main Street, Lynnfield. (Samples also taken at Chestnut Street however stations are within 170 meters of each other with no tributaries between them.)				
06/25/97 13:50	DEP	Swoffer 2100	0.06	0.09
07/29/97 8:30	DEM	Unknown	0.22	0.06
09/09/97 **	DEM	Unknown	**	0.05
10/21/97 10:30	DEM	----- Not enough flow to measure -----		
11/19/97 **	DEM	Unknown	**	0.29
01/21/98 **	DEM	Unknown	**	1.90

** = missing/censored data e = flow estimated see field sheet for details

Stream Water Quality Monitoring

All Dep water quality data is maintained in an Access Database (Dallaire 1999). The Hydrolab in-situ results are provided in Table B3. Discrete water sampling data includes physico/chemical (Table B4) and bacterial data (Table B5).

Table B3. 1997/1998 DEP DWM North Coastal Watershed, *in-situ* Hydrolab data.

	Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Cond (uS/cm)	TDS (g/l)	DO (mg/l)	SAT (%)	Turb (NTU)
Unnamed and/or Undefined SARIS									
Station: FF01 3/98, Mile Point: 0.2									
Description: upstream/west of Cabot Road Danvers. (unnamed tributary to Frost Fish Brook)									
93-0256	03/23/98	09:32	<0.3	5.2	6.2	1,292	0.8	11.5	90 19
ALEWIFE BROOK									
Station: AL01, Mile Point: 0.1									
Description: approximately 100 meters upstream/northeast of Babson Reservoir, Gloucester.									
93-0017	06/30/97	10:49	<0.3	17.8	5.3	152	0.10	1.9	20 --
CAT BROOK									
Station: SM02, Mile Point: 0.5									
Description: upstream/east at Norwood Avenue, Manchester. Midstream wade-in sample.									
93-0047	07/29/97	10:36	<0.3	16.4	6.3	255	0.2	5.5	55 **
CAT BROOK									
Station: SM01, Mile Point: 0.3									
Description: upstream/east at School Street, Manchester. Midstream wade-in sample.									
93-0020	06/30/97	11:51	<0.3	19.2	6.3	297	0.2	6.7	71 --
93-0046	07/29/97	09:56	<0.3	17.1	6.6	256	0.2	6.8	69 99*
93-0074	09/09/97	10:48	0.3	15.3	6.6	271	0.2	6.5	64 --
93-0096	10/21/97	13:45	<0.3	9.4	6.5	378	0.2	4.8	42 53*
93-0166	11/19/97	12:04	<0.3	2.5	5.8	367	0.2	12.6	90 --
93-0216	01/21/98	11:27	<0.3	1.0	5.6	365	0.2	13.3	92 --
93-0250	03/23/98	08:18	<0.3	0.83	5.0	240	0.2	12.5	87 8
BASS RIVER/Shoe Pond									
Station: BR01, Mile Point: 1.1									
Description: Shoe Pond outlet pipes, just south of Route 62, Beverly. (Pipes only visible at low tide.)									
93-0258	03/23/98	13:47	<0.3	5.4	6.6	1,887*	1.2	12.2	96 24
Pipe/Discharge to BASS RIVER									
Station: BR01P, Mile Point: 1.09									
Description: rusty pipe on the eastern side of Shoe Pond outlet pipes, just south of Route 62, Beverly. (Pipes only visible at low tide.)									
93-0262	03/23/98	13:51	**	**	**	**	**	**	** **
FROST FISH BROOK									
Station: FF01 7/97, Mile Point: 1									
Description: downstream/south at Cabot Road, Danvers. Midstream wade-in sample.									
93-0045	07/29/97	11:47	<0.3	16.8	7.0	364	0.2	8.7	88 **
FROST FISH BROOK									
Station: PR01, Mile Point: 0.01									
Description: upstream/north at Route 62, Danvers. Midstream wade-in sample.									
93-0016	06/30/97	12:33	<0.3	20.2	7.2	577	0.4	8.6	92 --
93-0044	07/29/97	12:15	<0.3	20.1	7.3	985*	0.6	7.8	85 **
93-0072	09/09/97	12:55	0.4	16.9	7.5	338	0.2	9.2	94 --
93-0092	10/21/97	13:02	<0.3	9.1	7.0	2,445*	1.6	8.1	70 **
93-0162	11/19/97	12:33	<0.3	3.5	7.2	693	0.4	13.0	96 --
93-0212	01/21/98	11:56	<0.3	2.5	7.1	812*	0.5	14.0	101 --
93-0255	03/23/98	09:01	<0.3	2.3	6.5	729	0.5	13.0	94 8

* = outside calibrated range, ** = censored data, -- = no data

Table B3. (Continued) 1997/1998 DEP DWM North Coastal Watershed, *in-situ* Hydrolab data.

		Time	Measurement	Temp	pH	Cond	TDS	DO	SAT	Turb
		(24hr)	Depth (m)	(°C)	(SU)	(uS/cm)	(g/l)	(mg/l)	(%)	(NTU)
CRANE RIVER										
Station: CR01, Mile Point: 1.6										
Description: upstream/west at Ash Street, Danvers. Midstream wade-in sample.										
93-0015	06/30/97	13:06	<0.3	25.5	7.3	694	0.4	6.0	72	--
93-0042	07/29/97	14:21	<0.3	23.2	7.4	748	0.5	6.1	70	14
93-0068	09/09/97	12:30	0.3	18.3	7.4	693	0.4	7.0	73	--
93-0091	10/21/97	12:38	<0.3	9.8	7.2	717	0.5	9.2	80	**
93-0161	11/19/97	13:03	<0.3	3.6	7.2	959*	0.6	11.7	86	--
93-0211	01/21/98	12:20	<0.3	2.0	7.0	1,521*	1.0	12.9	92	--
93-0254	03/23/98	10:06	**	**	**	**	**	**	**	**
BEAVER BROOK										
Station: CR03, Mile Point: 0.04										
Description: upstream/north at Holten Street, Danvers. Midstream wade-in sample.										
93-0010	06/25/97	14:15	<0.3	22.0	7.1	941*	0.6	9.8	110	--
93-0037	07/29/97	14:48	<0.3	22.2	6.8	1,004*	0.6	5.7	65	--
93-0070	09/09/97	14:46	0.3	18.4	6.7	725	0.5	4.8	51	--
CRANE BROOK										
Station: CR04, Mile Point: 1.2										
Description: approximately 20 feet downstream/northeast of Route 114 (in front of Chevrolet dealer), Danvers. Midstream wade-in sample.										
93-0036	07/29/97	14:11	<0.3	20.6	7.1	985*	0.6	6.3	70	--
93-0071	09/09/97	15:25	0.4	17.6	7.1	945*	0.6	5.4	55	--
93-0257	03/23/98	10:45	0.3	2.9	6.5	1,532*	1.0	12.5	92	10
CRANE BROOK										
Station: CR02, Mile Point: 0.2										
Description: downstream/east at Pine Street, Danvers. Midstream wade-in sample.										
93-0011	06/25/97	14:37	<0.3	18.3	7.1	688	0.4	5.9	61	--
93-0043	07/29/97	14:46	<0.3	19.4	7.2	673	0.4	7.5	80	**
93-0069	09/09/97	14:08	0.4	16.5	7.2	704	0.5	7.0	70	--
WATERS RIVER										
Station: WA02, Mile Point: 1.8										
Description: upstream/northwest at Mount Pleasant Drive, Peabody. Midstream wade-in sample.										
93-0041	07/29/97	--	----- Not enough flow to take sample-----							
WATERS RIVER										
Station: WA01, Mile Point: 1.5										
Description: downstream/east of Sylvan Street, Peabody. Midstream wade-in sample.										
93-0018	06/30/97	13:37	<0.3	18.2	7.1	842*	0.5	8.9	93	--
93-0040	07/29/97	13:36	<0.3	17.9	7.4	781	0.5	9.4	98	**
93-0067	09/09/97	11:27	0.4	16.3	7.5	699	0.4	9.1	92	--
93-0090	10/21/97	09:57	<0.3	12.1	7.2	2,776*	1.8	9.5	88	**
93-0160	11/19/97	10:42	<0.3	8.4	7.2	1,161*	0.7	8.8	74	--
93-0210	01/21/98	09:52	0.3	6.1	7.0	1,211*	0.8	10.7	85	--
93-0261	03/23/98	13:25	<0.3	6.2	6.5	2,336*	1.5	11.6	93	37

* = outside calibrated range, ** = censored data, -- = no data

Table B3. Continued. 1997/1998 DEP DWM North Coastal Watershed, *in-situ* Hydrolab data.

		Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Cond (uS/cm)	TDS (g/l)	DO (mg/l)	SAT (%)	Turb (NTU)
PROCTOR BROOK										
Station: NR01, Mile Point: 1.2										
Description: downstream/east at Howley Street, Peabody. Midstream wade-in sample. (At time of sampling in 1997, thought to be North River)										
93-0013	06/30/97	14:25	<0.3	23.3	7.2	739	0.5	7.4	85	—
93-0038	07/29/97	15:26	<0.3	21.6	7.4	745	0.5	7.2	81	**
93-0065	09/09/97	11:52	0.4	18.1	7.5	666	0.4	7.7	80	—
93-0094	10/21/97	10:36	<0.3	10.8	7.2	876*	0.6	8.0	71	**
93-0164	11/19/97	11:09	<0.3	3.7	7.2	961*	0.6	11.7	86	—
93-0214	01/21/98	10:31	0.3	2.1	6.9	1,538*	1.0	13.2	94	—
93-0260	03/23/98	12:58	<0.3	3.8	6.4	1,390	0.9	12.5	94	18
GOLDTHWAIT BROOK										
Station: GB01, Mile Point: 0.4										
Description: upstream/west at Foster Street, Peabody. Midstream wade-in sample.										
93-0095	10/21/97	—	Not enough flow to take sample					—	—	—
93-0165	11/19/97	11:25	<0.3	7.5	6.7	491	0.3	4.2	35	—
93-0215	01/21/98	10:54	<0.3	2.6	6.8	666	0.4	12.6	91	—
93-0252	03/23/98	11:13	0.3	3.4	6.5	650	0.4	12.7	94	**
FOREST RIVER										
Station: FR01, Mile Point: 1										
Description: upstream/west approximately 4/10 mile from Loring Avenue, Salem. Midstream wade-in sample.										
93-0019	06/30/97	15:07	<0.3	27.2	7.3	2,338*	1.5	6.8	85	—
93-0259	03/23/98	12:20	<0.3	3.4	6.7	340	0.2	12.5	93	8
SAUGUS RIVER										
Station: SR04, Mile Point: 13.2										
Description: outlet Lake Quannapowitt - downstream/east at Main Street, Wakefield (approximately 15 feet from road). Midstream wade-in sample.										
93-0009	06/25/97	11:52	<0.3	21.4	6.6	668	0.4	2.3	25	—
93-0034	07/29/97	13:09	<0.3	21.6	6.6	674	0.4	2.9	33	—
SAUGUS RIVER										
Station: SR03, Mile Point: 9.7										
Description: upstream/north at Salem Street, Wakefield/Lynnfield border. Midstream wade-in sample.										
93-0007	06/25/97	12:37	<0.3	19.6	7.0	738	0.5	6.8	72	—
93-0031	07/29/97	11:47	<0.3	16.7	7.0	910*	0.6	8.2	84	—
93-0061	09/09/97	12:18	<0.3	16.0	7.0	899*	0.6	8.2	81	5
93-0103	10/21/97	11:53	<0.3	10.5	6.9	878*	0.6	7.2	64	—
93-0155	11/19/97	10:39	<0.3	7.5	6.6	883*	0.6	7.9	64	1
93-0205	01/21/98	11:28	<0.3	1.2	6.3	432	0.3	8.1	57	<1
Pipe/Discharge to SAUGUS RIVER										
Station: SD01, Mile Point: 9.66										
Description: approximately 10 feet downstream/south of Salem Street, Wakefield. Stormdrain on western bank.										
93-0032	07/29/97	12:05	<0.3	17.9	7.3	1,419*	0.9	7.5	79	—
SAUGUS RIVER										
Station: SR02, Mile Point: 5.7										
Description: upstream/west at Route 1, Saugus (North Saugus). Midstream wade-in sample.										
93-0003	06/25/97	09:19	<0.3	18.4	7.2	611	0.4	6.2	65	—
93-0027	07/29/97	09:18	<0.3	20.9	7.1	568	0.4	4.8	54	—
93-0052	09/09/97	08:02	<0.3	16.9	7.2	614	0.4	5.5	56	14
93-0152	11/19/97	12:45	<0.3	2.5	6.8	758	0.5	11.6	83	8
93-0202	01/21/98	10:20	0.4	1.0	6.4	942*	0.6	11.8	82	3
SAUGUS RIVER										
Station: SR01, Mile Point: 4.2										
Description: east of the Saugus River Iron Works, due west of the end of Bridge Street, Saugus. Midstream wade-in sample.										
93-0001	06/25/97	08:39	<0.3	18.4	7.5	602	0.4	8.5	89	—
93-0025	07/29/97	08:40	<0.3	20.1	7.5	540	0.3	6.9	75	—
93-0050	09/09/97	07:18	<0.3	16.6	7.6	554	0.4	9.1	92	12
93-0098	10/21/97	10:41	0.4	8.5	7.4	588	0.4	10.8	91	—
93-0150	11/19/97	09:53	<0.3	2.1	6.8	729	0.5	12.8	91	10
93-0200	01/21/98	09:46	0.3	1.3	6.5	917*	0.6	13.0	91	**

* = outside calibrated range, ** = censored data, -- = no data

Table B3. Continued. 1997/1998 DEP DWM North Coastal Watershed, *in-situ* Hydrolab data.

		Time (24hr)	Measurement Depth (m)	Temp (°C)	pH (SU)	Cond (uS/cm)	TDS (g/l)	DO (mg/l)	SAT (%)	Turb (NTU)
HAWKES BROOK										
Station: HB02, Mile Point: 2.2										
Description: north of Hawkes Pond, downstream/south at Salem Street/Route 129, Lynnfield. Midstream wade-in sample.										
93-0006	06/25/97	11:09	<0.3	17.2	7.1	413	0.3	7.3	74	--
93-0029	07/29/97	10:46	<0.3	16.9	6.8	836*	0.5	6.1	63	--
93-0054	09/09/97	09:10	<0.3	15.7	6.8	862*	0.6	6.1	61	7
93-0101	10/21/97	14:26	<0.3	10.5	6.7	931*	0.6	4.5	40	--
HAWKES BROOK										
Station: HB01, Mile Point: 0.7										
Description: south of Hawkes Pond, upstream/north at Spring Street (which is east off Walnut Street), North Saugus. Midstream wade-in sample.										
93-0004	06/25/97	09:48	<0.3	15.3	6.9	596	0.4	5.6	55	--
93-0028	07/29/97	10:20	<0.3	18.4	7.1	502	0.3	7.3	77	--
93-0053	09/09/97	08:32	<0.3	15.8	7.2	518	0.3	8.0	79	**
93-0100	10/21/97	11:20	<0.3	9.5	6.9	433	0.3	7.0	60	--
93-0153	11/19/97	12:23	<0.3	4.9	6.8	490	0.3	10.2	78	13
93-0203	01/21/98	10:55	<0.3	2.8	6.3	667	0.4	10.1	73	**
Pipe/Discharge to MILL RIVER										
Station: MRP2, Mile Point: 1.21										
Description: upstream/north at Water Street/Route 129, Wakefield. Pipe entering from western shore, upstream of pipe MRP1.										
93-0058	09/09/97	10:11	**	**	**	**	**	**	**	**
MILL RIVER										
Station: MR02, Mile Point: 1.2										
Description: upstream/north at Water Street/Route 129, Wakefield. Midstream wade-in sample.										
93-0056	09/09/97	09:47	<0.3	17.7	9.1	416	0.3	4.1	43	9
Pipe/Discharge to MILL RIVER										
Station: MRP1, Mile Point: 1.2										
Description: upstream/north at Water Street/Route 129, Wakefield. Pipe entering from western shore, downstream of pipe MRP2.										
93-0057	09/09/97	10:02	**	**	**	**	**	**	**	**
MILL RIVER										
Station: MR01, Mile Point: 0.5										
Description: just upstream/west of Farm Street (which is south off of Route 129), Wakefield. Midstream wade-in sample.										
93-0055	09/09/97	10:38	<0.3	17.1	6.9	613	0.4	2.3	23	9
93-0102	10/21/97	12:17	0.4	8.0	6.9	743	0.5	3.3	28	--
93-0154	11/19/97	11:59	0.5	2.7	6.5	942*	0.6	7.5	54	12
93-0204	01/21/98	12:41	0.5	1.8	6.3	1,109*	0.7	10.2	72	4
MILL RIVER										
Station: MR03, Mile Point: 0.01										
Description: just upstream/west of confluence with Saugus River, south of Route 129 near Wakefield/Saugus border, Wakefield.										
93-0005	06/25/97	10:32	<0.3	17.9	8.0	504	0.3	5.8	60	--
93-0030	07/29/97	11:17	<0.3	21.0	6.8	516	0.3	2.2	25	--
93-0059	09/09/97	11:15	<0.3	16.3	6.7	655	0.4	2.0	20	14
BEAVERDAM BROOK										
Station: BB01, Mile Point: 1.2										
Description: upstream/north at Chestnut Street, Lynnfield. Midstream wade-in sample.										
93-0008	06/25/97	13:27	<0.3	17.3	7.4	461	0.3	6.6	67	--
93-0033	07/29/97	12:36	<0.3	18.9	7.4	447	0.3	6.1	65	--
93-0063	09/09/97	13:08	<0.3	16.1	7.5	440	0.3	6.0	60	**
93-0104	10/21/97	13:07	<0.3	7.9	7.4	444	0.3	5.2	44	--
93-0156	11/19/97	11:12	<0.3	1.8	6.9	403	0.3	9.8	69	25*
93-0206	01/21/98	12:06	<0.3	2.0	6.5	317	0.2	10.1	71	3
BEAVERDAM BROOK										
Station: BB01A, Mile Point: 1.16										
Description: downstream/south at Chestnut Street and downstream of pipe under bridge, (approximately 20 feet separating this and BB01), Lynnfield. Midstream wade-in sample.										
93-0106	10/21/97	13:18	0.3	7.3	7.4	445	0.3	5.2	43	--

* = outside calibrated range, ** = censored data, -- = no data

Table B4. 1997/1998 DEP DWM North Coastal Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted.

	Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
Unnamed and/or Undefined SARIS												
Station: FF01 3/98, Mile Point: 0.2												
Description: upstream/west of Cabot Road Danvers. (unnamed tributary to Frost Fish Brook)												
93-0256	03/23/98 9:32	31	93	--	400	<1.0	--	--	--	0.02	1.7	0.02
ALEWIFE BROOK												
Station: AL01, Mile Point: 0.1												
Description: approximately 100 meters upstream/northeast of Babson Reservoir, Gloucester.												
93-0017	06/30/97 10:49	7.5	18	--	30	8.5	--	--	--	0.34	0.04	0.09
CAT BROOK												
Station: SM02, Mile Point: 0.5												
Description: upstream/east at Norwood Avenue, Manchester. Midstream wade-in sample.												
93-0047	07/29/97 10:36	22	51	--	43	--	--	--	--	0.05	1.8	0.06
CAT BROOK												
Station: SM01, Mile Point: 0.3												
Description: upstream/east at School Street, Manchester. Midstream wade-in sample.												
93-0020	06/30/97 11:51	14	39	--	64	<2.5	--	--	--	0.15	1.1	0.11
93-0046	07/29/97 9:56	22	50	--	45	--	--	--	--	0.03	1.8	0.03
93-0074	09/09/97 10:48	25	56	--	47	--	--	--	--	0.02	1.5	0.04
93-0096	10/21/97 13:45	30	67	--	80	<2.5	--	--	--	0.03	0.97	0.06
93-0166	11/19/97 11:04	**	**	--	**	**	--	--	--	**	**	**
93-0216	01/21/98 11:27	5.0	27	--	85	1.0	--	--	--	0.04	0.19	0.02
93-0250	03/23/98 8:18	4.0	18	--	6.3	<1.0	--	--	--	0.02	0.16	**
93-0251	03/23/98 8:18	4.0	18	--	6.2	<1.0	--	--	--	<0.02	0.16	**
BASS RIVER/Shoe Pond												
Station: BR01, Mile Point: 1.1												
Description: Shoe Pond outlet pipes, just south of Route 62, Beverly. (Pipes only visible at low tide.)												
93-0258	03/23/98 13:47	37	120	--	580	4.7	--	--	--	0.25	0.81	0.05
FROST FISH BROOK												
Station: FF01 7/97, Mile Point: 1												
Description: downstream/south at Cabot Road, Danvers. Midstream wade-in sample.												
93-0045	07/29/97 11:47	43	73	--	58	--	--	--	--	0.03	2.0	0.03

* = interference ** = missing/censored data -- = no data

Table B4. Continued. 1997/1998 DEP DWM North Coastal Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted.

	Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
FROST FISH BROOK												
Station: PR01, Mile Point: 0.01												
Description: upstream/north at Route 62, Danvers. Midstream wade-in sample.												
93-0016	06/30/97	12:35	47	100	116	<2.5	--	--	--	0.04	1.5	0.04
93-0044	07/29/97	12:15	55	128	225	--	--	--	--	0.15	1.4	0.10
93-0072	09/09/97	12:55	43	73	57	<2.5	--	--	--	<0.02	0.93	0.05
93-0092	10/21/97	13:02	73	348	651	<2.5	--	--	--	1.4	0.79	0.14
93-0093	10/21/97	13:02	73	348	685	<2.5	--	--	--	1.4	0.75	0.13
93-0162	11/19/97	11:33	**	**	**	**	--	--	--	**	**	**
93-0163	11/19/97	11:33	**	**	**	**	--	--	--	**	**	**
93-0212	01/21/98	11:56	37	95	255	<1.0	--	--	--	0.02	1.2	0.01
93-0213	01/21/98	11:56	36	98	225	<1.0	--	--	--	0.02	1.2	0.02
93-0255	03/23/98	9:07	31	68	190	<1.0	--	--	--	0.03	1.3	0.02
CRANE RIVER												
Station: CR01, Mile Point: 1.6												
Description: upstream/west at Ash Street, Danvers. Midstream wade-in sample.												
93-0015	06/30/97	13:06	88	145	134	5.4	--	--	--	0.12	0.93	0.07
93-0042	07/29/97	14:21	88	147	160	--	--	--	--	0.06	0.72	0.06
93-0068	09/09/97	12:30	86	149	139	9.9	--	--	--	0.07	0.63	0.08
93-0091	10/21/97	12:38	95	195	147	5.2	--	--	--	0.05	1.0	0.06
93-0161	11/19/97	12:03	**	**	**	**	--	--	--	**	**	**
93-0211	01/21/98	12:20	73	163	470	2.0	--	--	--	0.32	0.93	0.02
93-0254	03/23/98	10:06	52	110	440	2.6	--	--	--	0.16	0.91	0.03
BEAVER BROOK												
Station: CR03, Mile Point: 0.04												
Description: upstream/north at Holten Street, Danvers. Midstream wade-in sample.												
93-0010	06/25/97	14:12	53	141	230	<2.5	--	--	--	0.03	1.4	0.06
93-0037	07/29/97	14:49	61	156	250	**	--	--	--	0.04	0.74	0.05
93-0070	09/09/97	14:46	49	122	171	<2.5	--	--	--	0.05	0.85	0.04
CRANE BROOK												
Station: CR04, Mile Point: 1.2												
Description: approximately 20 feet downstream/northeast of Route 114 (in front of Chevrolet dealer), Danvers. Midstream wade-in sample.												
93-0036	07/29/97	14:11	153	204	190	**	--	--	--	0.50	0.70	0.04
93-0071	09/09/97	15:25	184	236	160	<2.5	--	--	--	1.7	0.40	0.02
93-0257	03/23/98	10:47	100	160	220	1.4	--	--	--	0.63	1.5	0.02
CRANE BROOK												
Station: CR02, Mile Point: 0.2												
Description: downstream/east at Pine Street, Danvers. Midstream wade-in sample.												
93-0011	06/25/97	14:35	112	169	116	4.0	--	--	--	0.18	2.0	0.04
93-0043	07/29/97	14:46	101	149	125	--	--	--	--	0.03	1.9	0.04
93-0069	09/09/97	14:08	118	175	122	<2.5	--	--	--	0.14	2.2	0.05

* = interference ** = missing/censored data -- = no data

Table B4. Continued. 1997/1998 DEP DWM North Coastal Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted.

	Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
WATERS RIVER												
Station: WA02, Mile Point: 1.8												
Description: upstream/northwest at Mount Pleasant Drive, Peabody. Midstream waed-in sample.												
93-0041	07/29/97	**										
----- Not enough flow to take sample -----												
WATERS RIVER												
Station: WA01, Mile Point: 1.5												
Description: downstream/east of Sylvan Street, Peabody. Midstream waed-in sample.												
93-0018	06/30/97	13:37	74	158	175	<2.5	--	--	--	0.05	2.9	0.04
93-0040	07/29/97	13:36	77	143	160	--	--	--	--	0.09	3.3	0.04
93-0067	09/09/97	11:27	79	148	143	--	--	--	--	0.02	2.8	0.03
93-0090	10/21/97	9:57	80	407	735	3.4	--	--	--	0.05	2.8	0.02
93-0160	11/19/97	9:42	**	**	**	**	--	--	--	**	**	**
93-0210	01/21/98	9:52	61	155	325	1.7	--	--	--	0.07	1.5	0.05
93-0261	03/23/98	13:25	34	99	460	17	--	--	--	0.13	1.3	0.08
PROCTOR BROOK												
Station: NR01, Mile Point: 1.2												
Description: downstream/east at Howley Street, Peabody. Midstream waed-in sample. (At time of sampling in 1997, thought to be North River)												
93-0013	03-0014	06/30/97	14:25	70	117	<2.5	--	--	--	0.10	1.2	0.06
93-0014	03-0013	06/30/97	14:25	64	118	<2.5	--	--	--	0.11	1.3	0.07
93-0038	03-0039	07/29/97	15:26	86	123	--	--	--	--	0.11	1.7	0.13
93-0039	03-0038	07/29/97	15:26	86	128	--	--	--	--	0.11	1.7	0.14
93-0065	03-0066	09/09/97	11:52	80	126	<2.5	--	--	--	0.07	1.3	0.06
93-0066	03-0065	09/09/97	11:52	80	125	<2.5	--	--	--	0.06	1.2	0.06
93-0094	10/21/97	10:36	96	181	176	<2.5	--	--	--	0.26	1.4	0.08
93-0164	11/19/97	10:09	**	**	**	**	--	--	--	**	**	**
93-0214	01/21/98	10:31	44	117	460	1.4	--	--	--	0.58	1.3	0.03
93-0260	03/23/98	12:58	33	90	400	5.6	--	--	--	0.33	1.2	0.05
GOLDTHWAIT BROOK												
Station: GB01, Mile Point: 0.4												
Description: upstream/west at Foster Street, Peabody. Midstream waed-in sample.												
93-0095	10/21/97	**										
93-0165	11/19/97	10:25	**	**	**	**	--	--	--	**	**	**
93-0215	01/21/98	10:54	38	85	150	1.0	--	--	--	0.49	0.98	0.02
93-0252	03/23/98	11:13	30	68	180	1.1	--	--	--	0.28	1.1	0.02
----- Not enough flow to take sample -----												
* = interference ** = missing/censored data -- = no data												

Table B4. Continued. 1997/1998 DEP DWM North Coastal Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted.

	Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
FOREST RIVER												
Station: FR01, Mile Point: 1												
Description: upstream/west approximately 4/10 mile from Loring Avenue, Salem. Midstream wade-in sample.												
93-0019	06/30/97 15:07	97	297	--	650	16	--	--	--	0.11	0.27	0.09
93-0259	03/23/98 12:20	51	80	--	5.5	<1.0	--	--	--	0.02	0.13	0.02
SAUGUS RIVER												
Station: SR04, Mile Point: 13.2												
Description: outlet Lake Quannapowitt - downstream/east at Main Street, Wakefield (approximately 15 feet from road). Midstream wade-in sample.												
93-0009	06/25/97 12:34	47	74	--	150	134	--	--	--	0.66	0.36	0.08
93-0034	07/29/97 13:10	55	74	--	160	11	--	--	--	0.93	0.36	0.14
SAUGUS RIVER												
Station: SR03, Mile Point: 9.7												
Description: upstream/north at Salem Street, Wakefield/Lynnfield border. Midstream wade-in sample.												
93-0007	06/25/97 11:48	89	136	--	145	2.8	--	--	--	0.17	0.66	0.06
93-0031	07/29/97 11:48	94	145	--	215	**	--	--	--	0.17	1.1	0.04
93-0061	09/09/97 12:18	97	150	--	205	4.0	--	--	--	0.18	0.88	0.08
93-0103	10/21/97 11:53	100	171	--	200	<2.5	--	--	--	0.16	0.75	0.10
93-0155	11/19/97 10:39	91	123	--	210	**	--	--	--	0.25	0.85	**
93-0205	01/21/98 11:28	53	92	--	83	<1.0	--	--	--	0.03	0.37	0.02
Pipe/Discharge to SAUGUS RIVER												
Station: SD01, Mile Point: 9.66												
Description: approximately 10 feet downstream/south of Salem Street, Wakefield. Stormdrain on western bank.												
93-0032	07/29/97 12:05	139	129	--	340	**	--	--	--	0.09	2.6	0.04
93-0062	09/09/97 12:36	143	245	--	335	<2.5	--	--	--	0.09	1.9	0.07
SAUGUS RIVER												
Station: SR02, Mile Point: 5.7												
Description: upstream/west at Route 1, Saugus (North Saugus). Midstream wade-in sample.												
93-0003	06/25/97 9:15	63	107	--	124	7.0	--	--	--	0.03	0.92	0.07
93-0027	07/29/97 9:18	69	94	--	120	**	--	--	--	0.03	0.65	0.07
93-0052	09/09/97 8:01	77	115	--	130	3.4	--	--	--	<0.02	0.50	0.07
93-0152	11/19/97 12:46	54	105	--	175	**	--	--	--	0.13	0.58	**
93-0202	01/21/98 10:20	39	91	--	247	1.2	--	--	--	0.07	0.61	0.03

* = interference ** = missing/censored data -- = no data

Table B4. Continued. 1997/1998 DEP DWM North Coastal Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted.

	Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
SAUGUS RIVER												
Station: SR01, Mile Point: 4.2												
Description: east of the Saugus River Iron Works, due west of the end of Bridge Street, Saugus. Midstream wade-in sample.												
93-0001	93-0002	06/25/97	8:36	63	105	--	5.4	--	--	0.03	1.1	0.07
93-0002	93-0001	06/25/97	8:36	62	105	--	5.2	--	--	0.04	1.1	0.08
93-0025	93-0026	07/29/97	8:45	62	93	--	**	--	--	<0.02	0.99	0.06
93-0026	93-0025	07/29/97	8:45	63	95	--	**	--	--	0.02	0.97	0.06
93-0050	93-0051	09/09/97	7:17	69	109	--	<2.5	--	--	<0.02	0.83	0.04
93-0051	93-0050	09/09/97	7:17	68	107	--	<2.5	--	--	<0.02	0.82	0.03
93-0098	93-0099	10/21/97	10:41	69	138	--	<2.5	--	--	<0.02	0.52	0.03
93-0099	93-0098	10/21/97	10:41	70	138	--	<2.5	--	--	<0.02	0.51	0.03
93-0150	93-0151	11/19/97	9:44	50	99	--	**	--	--	0.10	0.73	**
93-0151	93-0150	11/19/97	9:54	51	100	--	**	--	--	0.09	0.73	**
93-0200	93-0201	01/21/98	9:46	42	90	--	4.0	--	--	0.07	0.69	0.02
93-0201	93-0200	01/21/98	9:46	40	92	--	4.6	--	--	0.06	0.68	0.03
HAWKES BROOK												
Station: HB02, Mile Point: 2.2												
Description: north of Hawkes Pond, downstream/south at Salem Street/Route 129, Lynnfield. Midstream wade-in sample.												
93-0006	06/25/97	11:06	44	70	77	--	5.4	--	--	<0.02	1.6	0.08
93-0029	07/29/97	10:47	72	123	205	--	**	--	--	<0.02	1.4	0.20
93-0054	09/09/97	9:09	69	128	195	--	3.6	--	--	<0.02	0.87	0.07
93-0101	10/21/97	14:25	64	145	230	--	<2.5	--	--	<0.02	0.65	0.05
HAWKES BROOK												
Station: HB01, Mile Point: 0.7												
Description: south of Hawkes Pond, upstream/north at Spring Street (which is east off Walnut Street), North Saugus. Midstream wade-in sample.												
93-0004	06/25/97	9:44	72	109	118	--	18	--	--	0.08	0.97	0.07
93-0028	07/29/97	10:19	78	106	128	--	**	--	--	0.07	0.99	0.04
93-0053	09/09/97	8:32	73	103	103	--	63	--	--	0.04	0.63	0.10
93-0100	10/21/97	11:19	72	117	77	--	8.0	--	--	0.05	0.20	0.08
93-0153	11/19/97	12:24	67	94	90	--	**	--	--	0.15	0.42	**
93-0203	01/21/98	10:55	47	96	160	--	1.4	--	--	0.09	1.0	0.04
Pipe/Discharge to MILL RIVER												
Station: MRP2, Mile Point: 1.21												
Description: upstream/north at Water Street/Route 129, Wakefield. Pipe entering from western shore, upstream of pipe MRP1.												
93-0058	09/09/97	10:10	66	117	133	--	<2.5	--	--	0.15	0.90	0.03
MILL RIVER												
Station: MR02, Mile Point: 1.2												
Description: upstream/north at Water Street/Route 129, Wakefield. Midstream wade-in sample.												
93-0056	09/09/97	9:46	81	86	71	--	3.8	--	--	0.21	0.42	0.06
* = interference ** = missing/censored data -- = no data												

Table B4. Continued. 1997/1998 DEP DWM North Coastal Watershed, instream physico/chemical data. All units in mg/L unless otherwise noted.

	Time (24hr)	Alkalinity	Hardness	Specific Conductivity (umhos)	Chloride	Suspended Solids	Total Solids	Turbidity (NTU)	Total Kjeldahl Nitrogen	Ammonia	Nitrate	Total Phosphorus
Pipe/Discharge to MILL RIVER												
Station: MRP1, Mile Point: 1.2												
Description: upstream/north at Water Street/Route 129, Wakefield. Pipe entering from western shore, downstream of pipe MRP2.												
93-0057	09/09/97	10:02	67	116	134	<2.5	--	--	--	0.16	0.91	0.03
MILL RIVER												
Station: MR01, Mile Point: 0.5												
Description: just upstream/west of Farm Street (which is south off of Route 129), Wakefield. Midstream wade-in sample.												
93-0055	09/09/97	10:37	76	106	129	<2.5	--	--	--	0.04	0.77	0.11
93-0102	10/21/97	12:17	76	148	163	3.6	--	--	--	0.06	0.76	0.21
93-0154	11/19/97	11:59	57	115	235	**	--	--	--	0.20	0.68	**
93-0204	01/21/98	12:41	41	101	285	1.2	--	--	--	0.14	0.87	0.03
MILL RIVER												
Station: MR03, Mile Point: 0.01												
Description: just upstream/west of confluence with Saugus River, south of Route 129 near Wakefield/Saugus border, Wakefield.												
93-0005	06/25/97	10:30	69	95	94	3.2	--	--	--	0.25	0.84	0.03
93-0030	07/29/97	11:18	60	81	105	**	--	--	--	0.03	0.86	0.12
93-0059	09/09/97	11:14	84	144	138	29	--	--	--	0.34	1.0	0.13
BEAVERDAM BROOK												
Station: BB01, Mile Point: 1.2												
Description: upstream/north at Chestnut Street, Lynnfield. Midstream wade-in sample.												
93-0008	06/25/97	13:25	132	173	50	12	--	--	--	0.04	2.6	0.09
93-0033	07/29/97	12:36	139	128	46	**	--	--	--	0.04	2.1	0.11
93-0063	09/09/97	13:08	153	187	41	9.4	--	--	--	0.03	1.9	0.08
93-0104	10/21/97	13:08	165	250	38	<2.5	--	--	--	<0.02	1.3	0.08
93-0156	11/19/97	11:12	107	148	38	**	--	--	--	0.02	1.7	**
93-0206	01/21/98	12:06	57	99	42	1.0	--	--	--	<0.02	1.7	0.03
BEAVERDAM BROOK												
Station: BB01A, Mile Point: 1.16												
Description: downstream/south at Chestnut Street and downstream of pipe under bridge, (approximately 20 feet separating this and BB01), Lynnfield. Midstream wade-in sample.												
93-0106	10/21/97	13:13	--	--	--	--	--	--	--	--	--	--

* = interference ** = missing/censored data -- = no data

Table B5. 1997/1998 DEP DWM North Coastal Watershed, bacteria data. Units in colonies/100mls.

		Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
Unnamed and/or Undefined SARIS						
Station: FF01 3/98, Mile Point: 0.2						
Description: upstream/west of Cabot Road Danvers. (unnamed tributary to Frost Fish Brook)						
93-0256		03/23/98 9:32	100	<20	--	--
ALEWIFE BROOK						
Station: AL01, Mile Point: 0.1						
Description: approximately 100 meters upstream/northeast of Babson Reservoir, Gloucester.						
93-0017		06/30/97 10:49	<20	20	--	--
CAT BROOK						
Station: SM02, Mile Point: 0.5						
Description: upstream/east at Norwood Avenue, Manchester. Midstream wade-in sample.						
93-0047		07/29/97 10:36	360	20	--	--
CAT BROOK						
Station: SM01, Mile Point: 0.3						
Description: upstream/east at School Street, Manchester. Midstream wade-in sample.						
93-0020		06/30/97 11:51	440	240	--	--
93-0046		07/29/97 9:56	400	20	--	--
93-0074		09/09/97 10:48	920	620	--	--
93-0096		10/21/97 13:45	800	400	--	--
93-0166		11/19/97 11:04	**	--	--	--
93-0216		01/21/98 11:27	<20	<20	--	--
93-0250	93-0251	03/23/98 8:18	<20	<20	--	--
93-0251	93-0250	03/23/98 8:18	<20	<20	--	--
BASS RIVER/Shoe Pond						
Station: BR01, Mile Point: 1.1						
Description: Shoe Pond outlet pipes, just south of Route 62, Beverly. (Pipes only visible at low tide.)						
93-0258		03/23/98 13:47	4,000	1,000	--	--
FROST FISH BROOK						
Station: FF01 7/97, Mile Point: 1						
Description: downstream/south at Cabot Road, Danvers. Midstream wade-in sample.						
93-0045		07/29/97 11:47	200	100	--	--
FROST FISH BROOK						
Station: PR01, Mile Point: 0.01						
Description: upstream/north at Route 62, Danvers. Midstream wade-in sample.						
93-0016		06/30/97 12:35	1,300	800	--	--
93-0044		07/29/97 12:15	200	140	--	--
93-0072		09/09/97 12:55	1,600	1,200	--	--
93-0092	93-0093	10/21/97 13:02	2,200	1,400	--	--
93-0093	93-0092	10/21/97 13:02	4,000	2,400	--	--
93-0162	93-0163	11/19/97 11:33	**	--	--	--
93-0163	93-0162	11/19/97 11:33	**	--	--	--
93-0212	93-0213	01/21/98 11:56	160	<20	--	--
93-0213	93-0212	01/21/98 11:56	20	<20	--	--
93-0255		03/23/98 9:07	<20	40	--	--
CRANE RIVER						
Station: CR01, Mile Point: 1.6						
Description: upstream/west at Ash Street, Danvers. Midstream wade-in sample.						
93-0015		06/30/97 13:06	240	60	--	--
93-0042		07/29/97 14:21	140	<20	--	--
93-0068		09/09/97 12:30	280	140	--	--
93-0091		10/21/97 12:38	2,400	400	--	--
93-0161		11/19/97 12:03	**	--	--	--
93-0211		01/21/98 12:20	100	40	--	--
93-0254		03/23/98 10:06	80	<20	--	--
* = interference ** = missing/censored data -- = no data						

Table B5. Continued. 1997/1998 DEP DWM North Coastal Watershed, bacteria data. Units in colonies/100mls.

		Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS	
BEAVER BROOK							
Station: CR03, Mile Point: 0.04							
Description: upstream/north at Holten Street, Danvers. Midstream wade-in sample.							
93-0010	06/25/97	14:12	280	--	--	--	
93-0037	07/29/97	14:49	540	280	--	--	
93-0070	09/09/97	14:46	540	340	--	--	
CRANE BROOK							
Station: CR04, Mile Point: 1.2							
Description: approximately 20 feet downstream/northeast of Route 114 (in front of Chevrolet dealer), Danvers.							
Midstream wade-in sample.							
93-0036	07/29/97	14:11	900	120	--	--	
93-0071	09/09/97	15:25	180	20	--	--	
93-0257	03/23/98	10:47	100	20	--	--	
CRANE BROOK							
Station: CR02, Mile Point: 0.2							
Description: downstream/east at Pine Street, Danvers. Midstream wade-in sample.							
93-0011	06/25/97	14:35	240	--	--	--	
93-0043	07/29/97	14:46	80	60	--	--	
93-0069	09/09/97	14:08	280	80	--	--	
WATERS RIVER							
Station: WA02, Mile Point: 1.8							
Description: upstream/northwest at Mount Pleasant Drive, Peabody. Midstream wade-in sample.							
93-0041	07/29/97	----- Not enough flow to take sample-----				**	
WATERS RIVER							
Station: WA01, Mile Point: 1.5							
Description: downstream/east of Sylvan Street, Peabody. Midstream wade-in sample.							
93-0018	06/30/97	13:37	500	80	--	--	
93-0040	07/29/97	13:36	840	20	--	--	
93-0067	09/09/97	11:27	200	40	--	--	
93-0090	10/21/97	9:57	3,200	1,200	--	--	
93-0160	11/19/97	9:42	**	--	--	--	
93-0210	01/21/98	9:52	200	20	--	--	
93-0261	03/23/98	13:25	240	20	--	--	
PROCTOR BROOK							
Station: NR01, Mile Point: 1.2							
Description: downstream/east at Howley Street, Peabody. Midstream wade-in sample. (At time of sampling in 1997, thought to be North River)							
93-0013	93-0014	06/30/97	14:25	1,100	640	--	
93-0014	93-0013	06/30/97	14:25	1,200	680	--	
93-0038	93-0039	07/29/97	15:26	32,000	6,000	--	
93-0039	93-0038	07/29/97	15:26	50,000	3,000	--	
93-0065	93-0066	09/09/97	11:52	1,500	460	--	
93-0066	93-0065	09/09/97	11:52	1,500	620	--	
93-0094		10/21/97	10:36	3,600	1,400	--	
93-0164		11/19/97	10:09	**	--	--	
93-0214		01/21/98	10:31	800	200	--	
93-0260		03/23/98	12:58	640	260	--	
GOLDTHWAIT BROOK							
Station: GB01, Mile Point: 0.4							
Description: upstream/west at Foster Street, Peabody. Midstream wade-in sample.							
93-0095		10/21/97	----- Not enough flow to take sample-----				**
93-0165		11/19/97	10:25	**	--	--	
93-0215		01/21/98	10:54	40	<20	--	
93-0252		03/23/98	11:13	<20	<20	--	
FOREST RIVER							
Station: FR01, Mile Point: 1							
Description: upstream/west approximately 4/10 mile from Loring Avenue, Salem. Midstream wade-in sample.							
93-0019		06/30/97	15:07	540	280	--	
93-0259		03/23/98	12:20	20	<20	--	
* = interference ** = missing/censored data -- = no data							

Table B5. Continued. 1997/1998 DEP DWM North Coastal Watershed, bacteria data. Units in colonies/100mls.

		Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
SAUGUS RIVER						
Station: SR04, Mile Point: 13.2						
Description: outlet Lake Quannapowitt - downstream/east at Main Street, Wakefield (approximately 15 feet from road). Midstream wade-in sample.						
93-0009		06/25/97 12:34	40	--	--	--
93-0034		07/29/97 13:10	160	<20	--	--
SAUGUS RIVER						
Station: SR03, Mile Point: 9.7						
Description: upstream/north at Salem Street, Wakefield/Lynnfield border. Midstream wade-in sample.						
93-0007		06/25/97 11:48	280	--	--	--
93-0031		07/29/97 11:48	160	40	--	--
93-0061		09/09/97 12:18	80	<20	--	--
93-0103		10/21/97 11:53	400	100	--	--
93-0155		11/19/97 10:39	<20	--	--	--
93-0205		01/21/98 11:28	<100	<20	--	--
Pipe/Discharge to SAUGUS RIVER						
Station: SD01, Mile Point: 9.66						
Description: approximately 10 feet downstream/south of Salem Street, Wakefield. Stormdrain on western bank.						
93-0032		07/29/97 12:05	60	20	--	--
93-0062		09/09/97 12:36	20	60	--	--
SAUGUS RIVER						
Station: SR02, Mile Point: 5.7						
Description: upstream/west at Route 1, Saugus (North Saugus). Midstream wade-in sample.						
93-0003		06/25/97 9:15	80	--	--	--
93-0027		07/29/97 9:18	520	60	--	--
93-0052		09/09/97 8:01	180	80	--	--
93-0152		11/19/97 12:46	320	--	--	--
93-0202		01/21/98 10:20	40	20	--	--
SAUGUS RIVER						
Station: SR01, Mile Point: 4.2						
Description: east of the Saugus River Iron Works, due west of the end of Bridge Street, Saugus. Midstream wade-in sample.						
93-0001	93-0002	06/25/97 8:36	60	--	--	--
93-0002	93-0001	06/25/97 8:36	60	--	--	--
93-0025	93-0026	07/29/97 8:45	620	120	--	--
93-0026	93-0025	07/29/97 8:45	560	100	--	--
93-0050	93-0051	09/09/97 7:17	2,800	1,300	--	--
93-0051	93-0050	09/09/97 7:17	2,100	1,200	--	--
93-0098	93-0099	10/21/97 10:41	1,200	200	--	--
93-0099	93-0098	10/21/97 10:41	600	140	--	--
93-0150	93-0151	11/19/97 9:44	1,700	--	--	--
93-0151	93-0150	11/19/97 9:54	860	--	--	--
93-0200	93-0201	01/21/98 9:46	<20	<20	--	--
93-0201	93-0200	01/21/98 9:46	20	20	--	--
HAWKES BROOK						
Station: HB02, Mile Point: 2.2						
Description: north of Hawkes Pond, downstream/south at Salem Street/Route 129, Lynnfield. Midstream wade-in sample.						
93-0006		06/25/97 11:06	1,200	--	--	--
93-0029		07/29/97 10:47	460	120	--	--
93-0054		09/09/97 9:09	1,400	700	--	--
93-0101		10/21/97 14:25	2,000	300	--	--
HAWKES BROOK						
Station: HB01, Mile Point: 0.7						
Description: south of Hawkes Pond, upstream/north at Spring Street (which is east off Walnut Street), North Saugus. Midstream wade-in sample.						
93-0004		06/25/97 9:44	680	--	--	--
93-0028		07/29/97 10:19	2,400	1,000	--	--
93-0053		09/09/97 8:32	820	600	--	--
93-0100		10/21/97 11:19	800	200	--	--
93-0153		11/19/97 12:24	400	--	--	--
93-0203		01/21/98 10:55	<20	<20	--	--

* = interference

** = missing/censored data

-- = no data

Table B5. Continued. 1997/1998 DEP DWM North Coastal Watershed, bacteria data. Units in colonies/100mls.

		Time (24hr)	FECAL	E-COLI	ENTEROCOCCUS	AEROMONAS
Pipe/Discharge to MILL RIVER						
Station: MRP2, Mile Point: 1.21						
Description: upstream/north at Water Street/Route 129, Wakefield. Pipe entering from western shore, upstream of pipe MRP1.						
93-0058	09/09/97	10:10	1,500	320	--	--
MILL RIVER						
Station: MR02, Mile Point: 1.2						
Description: upstream/north at Water Street/Route 129, Wakefield. Midstream wade-in sample.						
93-0056	09/09/97	9:46	40	40	--	--
Pipe/Discharge to MILL RIVER						
Station: MRP1, Mile Point: 1.2						
Description: upstream/north at Water Street/Route 129, Wakefield. Pipe entering from western shore, downstream of pipe MRP2.						
93-0057	09/09/97	10:02	1,300	480	--	--
MILL RIVER						
Station: MR01, Mile Point: 0.5						
Description: just upstream/west of Farm Street (which is south off of Route 129), Wakefield. Midstream wade-in sample.						
93-0055	09/09/97	10:37	280	120	--	--
93-0102	10/21/97	12:17	600	200	--	--
93-0154	11/19/97	11:59	200	--	--	--
93-0204	01/21/98	12:41	100	40	--	--
MILL RIVER						
Station: MR03, Mile Point: 0.01						
Description: just upstream/west of confluence with Saugus River, south of Route 129 near Wakefield/Saugus border, Wakefield.						
93-0005	06/25/97	10:30	420	--	--	--
93-0030	07/29/97	11:18	220	20	--	--
93-0059	09/09/97	11:14	60	60	--	--
BEAVERDAM BROOK						
Station: BB01, Mile Point: 1.2						
Description: upstream/north at Chestnut Street, Lynnfield. Midstream wade-in sample.						
93-0008	06/25/97	13:25	40	--	--	--
93-0033	07/29/97	12:36	2,000	480	--	--
93-0063	09/09/97	13:08	1,600	800	--	--
93-0104	10/21/97	13:08	200	<20	--	--
93-0156	11/19/97	11:12	<20	--	--	--
93-0206	01/21/98	12:06	20	20	--	--
BEAVERDAM BROOK						
Station: BB01A, Mile Point: 1.16						
Description: downstream/south at Chestnut Street and downstream of pipe under bridge, (approximately 20 feet separating this and BB01), Lynnfield. Midstream wade-in sample.						
93-0106	10/21/97	13:13	400	400	--	--
* = interference ** = missing/censored data -- = no data						

Macroinvertebrates

Results from DEP's 1997/1998 benthic macroinvertebrate study are presented in Appendix C of this report.

Periphyton

The dominant algal groups found in the subbasins of the North Coastal Watershed during 1997 were typically green algae (Chlorophyceae) although blue-green Cyanobacteria were also found (Cyanophyceae). In many cases, pools were sampled as well as riffles. In the low velocity runs and pools of enriched streams, the algal community is usually dominated by filamentous green algae (Biggs 1996), in areas with phosphorus enrichment, the benthic community can sometimes be dominated by the Cyanophyceae (Borchardt 1996). The pools and floating algal mats of Hawkes Brook at HB02, downstream from Salem St., Lynnfield and Goldthwait Brook (GB01, upstream from First Ave., Peabody, had abundant blue-green genera: *Lyngbya*, and *Oscillatoria*. In the North Coastal Watershed, the pools

typically had the opportunistic filamentous green alga *Spirogyra* sp. as the dominant alga. Frost Fish Brook at FF01 (upstream from Route 62, Danvers) had the marine green, *Enteromorpha* spp. which was dominant in the pool but was not abundant overall. It was more abundant on the downstream side of Route 62. Because the area just above Route 62 is a smelt spawning area, it is important to monitor the proliferation of green algae in the pools and riffles of this tributary as well as Porter River. Large algal biomass would indicate nutrient enrichment and can affect dissolved oxygen levels. Also, when the alga breaks down the particles can clog the interstitial spaces that leads to alteration of the invertebrate community. The survival of the smelt eggs can also be affected by algal growth, particularly if the fast growing blue-green Cyanobacteria and the filamentous green algae proliferate and cover the eggs.

Periphyton samplers were deployed at two systems in the North Coastal Watershed in 1997. Others would have been included if there were sufficient flow to cover the samplers. The two systems were the Crane Brook system and the Porter River system. The Crane Brook (CR04) station on the upstream side of Route 114, just above CR04, was located in an area of open canopy. The riparian zone was entirely planted in grass. The station was located in front of the Chevrolet dealership. The productivity was $P=93.33$ mg ash free weight/m²/day (Table B6). This was the lowest P value of the three stations sampled in this basin. The Crane Brook system periphyton production increased between CR04 and CR02 to 116 mg/m²/day. CR02 had a partially open canopy.

Production was the highest in the Porter River system at 270 mg/m²/day ash free dry weight. The station located at Route 62, Danvers has a partially open canopy and is tidally affected. Its main tributary, Frost Fish Brook, has one of the few remaining smelt spawning areas in the Danvers River system. It is important to monitor its biological communities and habitats so that the smelt spawning ground will not be further impaired. To provide some perspective for this P value for the Porter River, an enriched site on the Charles River at the Watertown Dam, Watertown was chosen for comparison. It had a P of 400 mg/m²/day. All the rock surfaces at this station had long streamers of green algae and is considered to be highly impacted. The Porter River is not degraded to that point yet but algal production is relatively high. The pools on the upstream side of Route 62 were dominated by the green filamentous alga *Enteromorpha* spp. and growth was also observed in the area where the artificial substrates were deployed. Prolific growth of this opportunistic alga can alter benthic habitats by filling in interstitial spaces with organic matter and reducing the available attachment sites for other slower growing algae or other invertebrates to grow.

Table B6. North Coastal Watershed Periphyton Production in Ash Free Weight (mg/m²/day) Sampled from 5 - 25 August 1997

Location	Ash Free Weight mg/m ² /day
Crane Brook upstream @ Rte 114, Danvers	93.3
Crane River upstream @ Ash St., Danvers	116
Porter River downstream @ Route 62, Danvers	270

Fish Toxics

Sampling at Lake Quannapowitt resulted in the collection (Table B7) of largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), white perch (*Morone americana*), common carp (*Cyprinus carpio*), brown bullhead (*Ameiurus nebulosis*), and black crappie (*Pomoxis nigromaculatus*). Species collected from Chebacco Lake were; largemouth bass, chain pickerel (*Esox niger*), brown bullhead, yellow perch, and bluegill (*Lepomis macrochirus*). In most cases fish selected for analysis represented species and sizes desirable by the angling public for consumption, as well as fish from different feeding guilds (i.e., predator, invertivore, omnivore).

Lead and cadmium levels were below minimum detection limits (Table B7) defined by EPA analytical methods ($Pb < 0.14$ mg/kg, and $Cd < 0.02$ mg/kg) in all samples analyzed from both ponds. Mercury ranged from 0.09 mg/kg in a composite sample of brown bullheads to 0.74 mg/kg in a composite sample of largemouth bass from Chebacco Lake. In Lake Quannapowitt, mercury ranged from below detection (0.02 mg/kg) in a composite sample of brown bullheads as well as one individually analyzed common carp to a high of 0.22 mg/kg in a sample of white perch. Arsenic levels were mostly undetectable (< 0.04 mg/kg) in fish from Chebacco Lake, although values of 0.046 mg/kg and 0.058 mg/kg were revealed in composite samples of yellow perch and largemouth bass respectively. Arsenic levels in fish from Lake

Quannapowitt ranged from <0.04 mg/kg in white perch and largemouth bass to 0.22 mg/kg in brown bullheads. Selenium was detected in all samples from both ponds. In fish from Chebacco Lake, levels ranged from 0.071 mg/kg in a sample of brown bullheads to 0.235 mg/kg in a sample of yellow perch. Levels in Lake Quannapowitt fish ranged between 0.22 mg/kg in a composite of brown bullheads to 0.347 mg/kg in a composite sample of largemouth bass. Neither PCB nor organochlorine pesticides were detected in any of the samples analyzed

Table B7. 1997/1998 DEP DWM North Coastal Watershed fish toxics monitoring data (mg/kg unless otherwise noted). All concentrations are in wet weight.

Analysis #	Sample ID	Collection Date	Species Code ¹	Sample Type ²	Length (cm)	Weight (gm)	Cd	Pb	Hg	As	Se	%Lipids	PCB (µg/g)	Pesticides (µg/g)
Lake Quannapowitt, Station F0061: In Wakefield.														
98001	LQF98-01	5/18/98	C	I	43.7	1200	<0.020	<0.140	<0.020	0.090	0.345	0.59	ND	0.027*
98002	LQF98-02	5/18/98	LMB	C	34.5	630	<0.020	<0.140	0.08	<0.040	0.347	0.20	ND	ND
	LQF98-03	5/18/98	LMB	C	34.5	590								
	LQF98-04	5/18/98	LMB	C	33.7	610								
98003	LQF98-05	5/18/98	BB	C	30.5	340	<0.020	<0.140	<0.020	0.220	0.220	0.10	ND	ND
	LQF98-06	5/18/98	BB	C	28.3	300								
	LQF98-07	5/18/98	BB	C	26.6	260								
98004	LQF98-08	5/18/98	YP	C	27.7	220	<0.020	<0.20	0.060	0.043	0.327	0.12	ND	ND
	LQF98-09	5/18/98	YP	C	27.4	240								
	LQF98-10	5/18/98	YP	C	25.5	200								
98005	LQF98-11	5/18/98	WP	C	30.1	390	<0.020	<0.20	0.220	<0.040	0.324	0.31	ND	0.025*
	LQF98-12	5/18/98	WP	C	31.5	480								
	LQF98-13	5/18/98	WP	C	29.3	340								
98006	LQF98-14	5/18/98	BC	C	28.4	360	<0.020	<0.20	0.040	0.049	0.332	0.10	ND	ND
	LQF98-15	5/18/98	BC	C	25.3	240								
Chebacco Lake, Station F0062: in Essex/Hamilton.														
98007	CHF98-01	6/3/98	LMB	C	40.6	840	<0.02	<0.14	0.74	0.058	0.127	0.06	ND	ND
	CHF98-02	6/3/98	LMB	C	39.8	840								
	CHF98-03	6/3/98	LMB	C	35.7	540								
98008	CHF98-04	6/3/98	CP	C	40.6	400	<0.02	<0.14	0.37	<0.040	0.126	0.06	ND	ND
	CHF98-05	6/3/98	CP	C	43.2	440								
	CHF98-06	6/3/98	CP	C	41.9	400								
98009	CHF98-07	6/3/98	BB	C	31.3	400	<0.02	<0.14	0.09	<0.040	0.071	0.23	ND	ND
	CHF98-08	6/3/98	BB	C	30.5	370								
	CHF98-09	6/3/98	BB	C	33.1	470								
98010	CHF98-10	6/3/98	YP	C	23.0	140	<0.02	<0.14	0.29	0.046	0.235	0.14	ND	ND
	CHF98-11	6/3/98	YP	C	23.5	160								
	CHF98-12	6/3/98	YP	C	22.6	140								
98011	CHF98-13	6/3/98	B	C	22.4	220	<0.02	<0.14	0.29	<0.040	0.208	0.05	ND	ND
	CHF98-14	6/3/98	B	C	19.2	170								
	CHF98-15	6/3/98	B	C	19.6	170								

¹Species: bluegill (B) *Lepomis macrochirus*
brown bullhead (BB) *Ameiurus nebulosus*
black crappie (BC) *Pomoxis nigromaculatus*
common carp (C) *Cyprinus carpio*
chain pickerel (CP) *Esox niger*
largemouth bass (LMB) *Micropterus salmoides*
white perch (WP) *Morone americana*
yellow perch (YP) *Perca flavescens*

²Sample Type (All samples were fillets with skin off.)
Composite (C)
Individual (I)

*DDE

ND - not detected or analytical result is at or below established minimum detection limit (MDL)

Lakes

Lake synoptic survey results (MA DEP 1997) are presented in Table B8.

Table B8. 1997 DEP DWM North Coastal Watershed lake survey data.

Lake Location	Size (Acres)	Trophic State	Observations and/or Objectionable Conditions	Potential Threats To Water Quality
Babson Reservoir, ¹ Gloucester	29	U	Non-native plant (<i>Lythrum salicaria</i>), Floating scum and bird waste	Gulls
Beck Pond, Hamilton	40	E	Non-native plant (<i>Lythrum salicaria</i>)	Residential development
Birch Pond Reservoir, ¹ Lynn/ Saugus	80	U	Non-native plant (<i>Lythrum salicaria</i>)	Road runoff
Breeds Pond ¹ Lynn	177	U	Non-native plant (<i>Lythrum salicaria</i>), LWSC Public Water Supply (PWS)	Gulls and geese, water withdrawal
Browns Pond ¹ Peabody	25	M	Non-native plant (<i>Lythrum salicaria</i>)	Residential development
Buswell Pond Gloucester	7	E	Moderate algal bloom, floating scum and sheen, silt, excessive, noxious plants occupy 90% of lake	None noted
Cape Pond ¹ Rockport	41	E	Non-native plants (<i>Lythrum salicaria</i> , <i>Phragmites australis</i>), moderate turbidity (grey/green), algal blooms, floating scum and bird waste, silt, low transparency, Rockport DPW PWS	Gulls and cormorants, water withdrawal
Chebacco Lake Hamilton/ Essex	204	E	Non-native plants (<i>Lythrum salicaria</i> , <i>Potamogeton crispus</i> , and excessive growth of <i>Cabomba caroliniana</i>)	Residential development
Cedar Pond Peabody	11	U	Non-native plant (<i>Phragmites australis</i>) encroachment – 50% of pond consumed	Road runoff
Coy Pond Wenham	25	E	Non-native plant (<i>Lythrum salicaria</i>), excessive turbidity/low transparency, algal blooms, very dense weed cover	None noted
Crane River Pond Danvers	18	U	Non-native plant (<i>Phragmites australis</i>)	Urban development
Crystal Lake ¹ Wakefield/ Stoneham	80	M	Non-native plant (<i>Lythrum salicaria</i>), Wakefield Water Department	Urban development, water withdrawal
Days Pond (Fugro East, Inc., '95) Gloucester	1	H	None noted	None noted
Fernwood Lake ¹ Gloucester	26	U	Non-native plant (<i>Lythrum salicaria</i>)	Residential development
Flax Pond Lynn	49	E	Non-native plants (<i>Lythrum salicaria</i> <i>Potamogeton crispus</i>), moderate turbidity/low transparency, algal blooms	Urban development
Floating Bridge Pond Lynn	10	E	Non-native plants (<i>Lythrum salicaria</i> , <i>Phragmites australis</i>), excessive turbidity/low transparency, algal blooms, siltation	Urban development
Goose Cove Reservoir ¹ Gloucester	58	U	Non-native plant (<i>Lythrum salicaria</i>), Gloucester PWS, floating bird waste, water-level very low	Gulls and cormorants, water withdrawal
Gravelly Pond ¹ Hamilton	46	U	Non-native plant (<i>Lythrum salicaria</i>), siltation, water-level very low, Manchester PWS	Waterfowl
Griswold Pond ² (First Lake) Saugus	13	E	Non-native plants (<i>Lythrum salicaria</i> , <i>Myriophyllum heterophyllum</i> , <i>Cabomba</i> <i>caroliniana</i>), excessive weed growth covers entire pond	Residential development, road runoff
Haskell Pond ¹ Gloucester	48	U	Non-native plant (<i>Lythrum salicaria</i>), PWS, algal blooms	Road runoff, water withdrawal

¹ Class A (water supply) waterbody; all others are Class B.

² Outstanding Resource Water (ORW); Area of Critical Environmental Concern (ACEC); PWS = Public Water Supply.

Trophic State: O= Oligotrophic, M= Mesotrophic, E= Eutrophic, H= Hypereutrophic, U= Undetermined.

Table B8. Continued. 1997 DEP DWM North Coastal Watershed lake survey data.

Lake Location	Size (Acres)	Trophic State	Observations and/or Objectionable Conditions	Potential Threats To Water Quality
Hawkes Pond ¹ Lynnfield/ Saugus	73	E	Non-native plant (<i>Lythrum salicaria</i>), water level lowered for dam repair, algae, excessive turbidity/low transparency	Dam project (MEPA), road runoff (Rt. 1)
Lily Pond Gloucester	31	H	Non-native plant (<i>Lythrum salicaria</i>), excessive turbidity/low transparency, moderate algal blooms, siltation, trash and debris, excessive weed growth	Railroad tracks, road/parking lot runoff
Lower Pond (Pearce Lake) Saugus	19	E	Breakheart Reservation (MDC), public beach, excessive weed growth	Beach, waterfowl
Mill Pond Gloucester	21	U	Non-native plant (<i>Phragmites australis</i>), tidal pond, moderately turbid, algae,	Residential development
Niles Pond Gloucester	35	E	Non-native plant (<i>Phragmites australis</i>) encroachment 90 % of shoreline, heavy algae, moderate turbidity, excessive weed growth, siltation, surface sheen/film	Residential development, gulls
Pillings Pond Lynnfield	96	E	Non-native plant (<i>Lythrum salicaria</i>), pond mostly drained for dredging, heavy equipment operating, high turbidity/low transparency, siltation	Residential development, construction
Porters Pond Danvers	20	U	Non-native plant (<i>Phragmites australis</i>), Tidal pond, slightly turbid, algae,	Road runoff, urban development
Lake Quannapowitt Wakefield	250	E	Non-native plant (<i>Lythrum salicaria</i>), high turbidity/low transparency, heavy algae,	Urban development
Quarry Reservoir ¹ Rockport	5	U	Rockport PWS, bird waste, slight algal bloom	Water withdrawal, gulls
Round Pond Hamilton	37	U	Non-native plant (<i>Lythrum salicaria</i>), Manchester PWS	Water withdrawal
Rum Rock Lake Rockport	9	U	Non-native plant (<i>Lythrum salicaria</i>)	Residential development, horse farm
Seaplane Basin Revere	53	U	Non-native plant (<i>Phragmites australis</i>) surrounds pond, tidal pond	Heavy urban development, road runoff
Shoe Pond Beverly	8	E	High turbidity/low transparency, algae, siltation	Industrial park renovation
Sluice Pond Lynn	39	E	Slight turbidity and algae	Residential development
Spring Pond ² Saugus	9	H	Non-native plants (<i>Lythrum salicaria</i> , <i>Myriophyllum heterophyllum</i> , <i>Cabomba caroliniana</i>), 100 % weed cover, siltation	Residential development, high tension lines
Spring Pond Lynn/ Peabody/ Salem	59	M	Non-native plants (<i>Lythrum salicaria</i> , <i>Eichornia crassipes</i>), Peabody PWS, slight turbidity and algae	Water withdrawal
Spring Pond (Upper) ¹ Peabody	10	E	Peabody PWS, slight turbidity and algae, siltation	High tension lines, water withdrawal
Strangman Pond Gloucester	3	H	High turbidity/low transparency, algae, siltation, surface sheen, excessive weed growth	Sportsman's club runoff
Upper Banjo Pond Gloucester	11	E	Non-native plant (<i>Lythrum salicaria</i>), high turbidity/low transparency, algae, siltation, excessive weed growth	None noted
Upper Pond (Silver Lake) Saugus	13	M	Breakheart Reservation MDC, slight turbidity and algae	Waterfowl
Walden Pond ¹ Lynn/ Lynnfield/ Saugus	231	U	Non-native plant (<i>Lythrum salicaria</i>), LWSC Public Water Supply	Water withdrawal
Wallace Pond ¹ Gloucester	23	U	Non-native plant (<i>Lythrum salicaria</i>), Gloucester PWS, moderate algal bloom, siltation	Water withdrawal
Waters River Pond Danvers	57	U	Non-native plant (<i>Phragmites australis</i>), tidal pond, slight turbidity	Urban development

¹ Class A (water supply) waterbody; all others are Class B.² Outstanding Resource Water (ORW); Area of Critical Environmental Concern (ACEC) PWS = Public Water Supply.

Trophic State: O= Oligotrophic, M= Mesotrophic, E= Eutrophic, H= Hypereutrophic, U= Undetermined.

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APPENDIX C - DEP BIOMONITORING TECHNICAL MEMORANDUM

To: North Coastal Watershed Team; Larry Gil, EOE Watershed Team Leader
From: Robert Nuzzo, DEP/DWM
Date: 6 August 1998

NORTH COASTAL WATERSHED 1997 BIOMONITORING RESULTS

INTRODUCTION

Aquatic macroinvertebrates were collected from the North Coastal Watershed of Massachusetts as part of "year two" monitoring activities. Together with habitat quality evaluations conducted in conjunction with the collections these data will help the watershed team screen for some of the more serious water quality problems within the watershed. Distinguishing grades of impairment from these data, however, is difficult or impossible because no suitable reference site was found.

Attached at the end of this report are a glossary of terms, abbreviations, and acronyms used in this report (Attachment A) and a list showing the common names and classification of organisms collected at the North Coastal Watershed sites (Attachment B).

METHODS

Aquatic macroinvertebrates were collected from selected sites within the watershed by kick-sampling. Ten individual kicks taken within a 100 m reach of the selected stream were composited, representing a total sample area of 2 m². Collected material was transferred to a plastic jar, labeled, and preserved with denatured 95% ethanol. Habitat quality was scored at each sampling location following a habitat assessment procedure modified from Plafkin, *et al.* (1989). At sites where the kick-sampling methodology could not be applied a qualitative sample was collected by kicking bottom sediments, jabbing under banks, and sweeping through submergent and emergent vegetation.

Specimens were sorted from the sample debris using a randomized subsampling technique until a subsample containing 100 ± 10 organisms was obtained. Specimens were identified to family so that RBP II metrics (Plafkin *et al.* 1989) could be calculated. No subsorting was done for qualitative samples. Instead, specimens were removed from the sample only if they were different from what had already been removed, thereby giving an indication of the diversity within the sample.

Alewife Brook in Gloucester had been selected to serve as the reference for this watershed. At the time sampling was conducted (July 1997), however, there was no flowing water in its channel between its wetland headwaters and Babson Reservoir. Though not well suited to serve as reference sites because of the extent of development adjacent to, and upstream from them, the Frost Fish Brook site in Danvers (FF01) and the Saugus River site in Saugus (SR01) were selected to serve as the best alternative references.

RESULTS AND DISCUSSION

Alewife Brook between Eastern Ave./Main St. (Gloucester/Rockport) and Babson Reservoir, Gloucester, MA

At the time of reconnaissance (23 June 1997) Alewife Brook upstream from Babson Reservoir appeared to be an excellent choice to serve as a reference site for biomonitoring. Though it drained a relatively small area (many of the North Coastal Watershed streams of interest to the team drained fairly small areas) a good portion of this reach offered good habitat for stream macroinvertebrates. About 500 m upstream from Babson Reservoir the brook descended from wetlands to flow swiftly at the edge of the woods along the flank of Railcut Hill. At about 300 m upstream from Babson Reservoir the brook emerged from the woods to flow through mud flats (pond bottom at higher water) before crossing under

the railroad tracks and entering the reservoir. The portion flowing through the woods offered many good habitat qualities: riffles, rocky substrates, channel sinuosity, and an undisturbed riparian zone.

When we returned to sample Alewife Brook on 29 July 1997 there was no flowing water—only isolated pools in the flowing water reach and standing water in the upstream wetland portions of the brook. The mudflat area appeared to be completely dry, thus the brook was not conveying any water to the reservoir. The water level in the reservoir itself appeared to have dropped about 3 m since the month prior. No water was flowing out of Babson Reservoir; the outlet channel had water but it appeared stagnant.

Sawmill Brook (SM01) from confluence with Cat Brook to School Street, Manchester, MA

The brook was generally shallow, with laminar flow and mucky to sandy substrates—save for a very limited stretch of riffle over gravelly substrates—downstream to Norwood Street. From Norwood Street downstream to School Street the substrates were generally rocky and the flow velocity improves to create riffles. Still, the habitat in this reach was not ideal because of the fact that houses were perched along the banks throughout.

At the time of sampling (29 July 1997) water volume had dropped to the point that there was insufficient flowing water to provide adequate habitat for applying RBP assessments, but qualitative samples were collected. Nine different families of macroinvertebrates were found at this site (listed in Table C1). This was better than we might have anticipated, considering the severe habitat limitations we witnessed on that date. The total habitat score was 90 (out of a possible 200 points), with nearly all habitat considerations scoring low because of effects from insufficient flow.

Table C1. List of benthic macroinvertebrates collected (qualitative) in July 1997 at three sites in the North Coastal Watershed of Massachusetts: Sawmill Brook (SM01) upstream from School St., Manchester, MA; Waters River downstream from Sylvan St., Peabody/Danvers, MA; Saugus River at Camp Nihan, Saugus, MA. Presence at a site is marked with an "X."

TAXON*	SM01	WA01	SR02B
Unionidae			X
Enchytraeidae		X	
Tubificidae		X	
Naididae	X		
Lumbricina		X	
Glossiphoniidae			X
Asellidae	X		
Gammaridae	X	X	X
Aeshnidae	X		X
Corydalidae	X		
Philopotamidae	X		
Polycentropodidae			X
Hydropsychidae	X		
Dytiscidae		X	
Chironomidae	X	X	X
Empididae	X		

* See Attachment B.

Frost Fish Brook (FF01) downstream from Hemlock Street, Danvers, MA

The salt marsh and tidal flats associated with the Porter River extend right up to Route 62 in Danvers. There was evidence that the tide may influence water levels for another 200 m upstream from the Route 62 bridge (presumed to be the downstream limit of Frost Fish Brook). I only saw this brook when the tide was out so I cannot attest to what degree the tide may be an influence here. Salt water probably does not intrude upstream from the road, however, since midges and caddisflies were seen in the stream almost immediately upstream from the bridge. This watershed is extensively developed with suburban single-

family homes but the stream offers very good aquatic habitat at least as far upstream as the cul-de-sac at the end of Hemlock Street and running parallel to Sycamore Street. We chose a 100 m sample reach just downstream from Hemlock Street because it was clearly above any tidal influence and because of the good habitat it offered (score: 138).

The assemblage of macroinvertebrates from this site was represented by 10 families—as good, or better, richness as at any of the six RBP sites from this biomonitoring survey (Table C2). Lacking a truly suitable reference site for the North Coastal Watershed the best site for comparisons of RBP II results (Table C3) was the Saugus River downstream from Elm Street, Saugus (SR01); but the drainage area at that point on the Saugus River is much greater than for Frost Fish Brook at FF01. The resultant RBP II analysis ranked FF01 as moderately impaired. The biotic index was a little higher (higher BI values indicate worse impairment) than at SR01 but the RBP II ranking was most influenced by the paucity of EPT taxa (only one). SR01 itself only had two EPT taxa, however. Under these circumstances the RBP II results should not be interpreted to support a case for or against any significant impairment of aquatic life in Frost Fish Brook.

Crane River (CR01) upstream from Ash Street, Danvers, MA

The sample reach was a short distance upstream from Ash Street in a stretch that appeared to offer very good habitat (habitat score: 145). The stream channel seemed to have a natural sinuosity, there were well developed riffles over coarse substrates, and snags of fallen tree limbs provided additional habitat for invertebrates and fish. An abundance of bricks (a lot of the “cobble” substrate instream was actually brick) and old pipes in the riparian zone/flood plain was evidence that the land adjacent to the stream was once the site of a mill of some kind.

The riparian zone on both sides of the stream was mostly wooded with good bank vegetative coverage, yet there was much evidence of bank erosion within the sample reach. Instream the vegetative coverage was minimal, consisting mainly of mosses. The substrates were covered with fine particulate organic matter (FPOM).

The sample from this site yielded fewer families (Table C2) than four of the other five RBP sites, yet it had one of the two highest habitat scores. When RBP II metrics are calculated using SR01 as the reference (Table C3) CR01 falls within the moderately impaired category (as did FF01). When gaged against FF01 (Table C4), a site more comparable in habitat quality and watershed area than SR01, this Crane River site ranks as nonimpaired.

Waters River downstream from Sylvan Street, Peabody, MA

The watershed of Waters River is quite small and heavily developed. Downstream from Sylvan Street the stream channel is bordered by parking lots until it enters the salt marsh—a stretch of about only 100 m or so. The aquatic habitat in the freshwater portion of this river was poor (score: 80), with little flow at the time of sampling. This reach is little more than an open rubbish trough with water trickling through it. There was lots of trash cascading down the steep embankments from the parking lots. A storm drain coming in at the south side of the lower portion of this reach was bringing in a heavy load of silt and sand—suggesting that some attention to storm water management may be needed.

Though the availability of suitable substrate was adequate the current velocity was generally insufficient in this reach to apply RBP sampling. Macroinvertebrates were collected qualitatively, however, to inventory the groups present (Table C1). Representatives of six different families were found.

Table C2. List of benthic macroinvertebrates collected (RBP kick-samples) in July 1997 at six biomonitoring stations in the North Coastal Watershed of Massachusetts: North River downstream from Howley St., Peabody (NR01); Crane River upstream from Ash St., Danvers (CR01); Frost Fish Brook upstream from Route 62, Danvers (FF01); Hawkes Brook at the inlet to Hawkes Pond, Lynnfield (HB02); Saugus River downstream from Elm St., Saugus (SR01); Saugus River upstream from Lowell St./Salem St., Wakefield/Lynnfield (SR03).

TAXON ¹	FFG ²	TOLVAL ³	NR01	CR01	FF01	HB02	SR01	SR03
Hydrobiidae (?)	SC	8					1	
Physidae	GC	8				4	1	1
Pisidiidae	FC	6		3		1		
Enchytraeidae	GC	10				1	1	
Tubificidae	GC	10		14		5		2
Naididae	GC	9			6	4	3	1
Lumbriculidae	GC	7			8			
Asellidae	GC	8				6	2	20
Gammaridae	GC	6	108	17	15	72	10	24
Hydropsychidae	FC	4		40	16	4	47	49
Glossosomatidae	SC	0					9	
Psephenidae	SC	4			1			
Elmidae	SC	4		29	19			
Tipulidae	SH	5			1			1
Simuliidae	FC	6			3	1	1	1
Chironomidae	GC	6		4	32	7	23	3
Empididae	PR	6			5			1
TOTAL			108	107	106	105	98	103
HBI			6.0	5.2	5.6	6.5	4.7	5.6
FAMILIES			1	6	10	10	10	10

¹See Attachment B.

²FFG— Functional feeding group: scrapers (SC), gathering collectors (GC), filtering collectors (FC), predators (PR). (See Attachment A.)

³TOLVAL—Pollution tolerance value in the range 0 to 10: 0=very pollution intolerant; 10=very pollution tolerant. (See Attachment A.)

Goldthwaite Brook and North River (NR01) downstream from Howley Street, Peabody, MA

Goldthwaite Brook was examined with the hopes of identifying a biomonitoring site downstream from Eastman Gelatin as well as a site well above downtown Peabody that might serve as something of a reference. Nearly the entire length of Goldthwaite Brook, however, had very poor macroinvertebrate habitat and was not suitable for application of the RBP methodologies. Downstream from Eastman Gelatin there was a very low volume of water (even in June) flowing over substrates that at best were gravelly. As it passes through downtown Peabody the brook is typically contained in concrete channels or runs underground. When we saw it in July (1997) there was only standing water in the channel between Foster Street and Oak Street, often broken into isolated pools. Looking upstream from Foster Street the water was stagnant and putrid-looking. Stretches of the brook between here and the upstream railroad crossing at Eastman Gelatin were completely dry.

Table C3. Summary of RBP II data analysis for macroinvertebrate communities sampled in the North Coastal Watershed during July 1997. Seven biological metrics were calculated and scored (in *italic*) for taxa collected at each station. Scores were then totaled and compared to an upstream reference station (SR01 – Saugus River downstream from Elm Street, Saugus, MA). The percent comparability to the reference station yields a final impairment score for each study site.

Station #	SR01		SR03		FF01		CR01		NR01		HB02	
Stream	Saugus River Saugus, MA		Saugus River Wakefield/Lynnfield, MA		Frost Fish Brook Danvers, MA		Crane River Danvers, MA		North River Peabody, MA		Hawkes Brook Lynnfield, MA	
Habitat Score	186/200		97/186=52% nonsupporting		138/186=74% supporting		145/186=78% supporting		95/186=51% nonsupporting		124/186=67% partially supporting	
Taxa Richness	10	6	10/10	6	10/10	6	6/10	3	1/10	0	10/10	6
Biotic Index	4.7	6	4.7/5.6	3	4.7/5.6	3	4.7/5.2	6	4.7/6.0	3	4.7/6.5	3
Ept Index	2	6	½	0	½	0	½	0	0	0	½	0
Ept/Chironomidae	2.4	6	16/2.4	6	0.5/2.4	0	10/2.4	3	0	0	0.57/2.4	0
Riffle Community: Scrapers/Filt. Coll.	0.21	6	0	0	1.1/0.21	6	0.67/0.21	6	0	0	0	0
% Contribution (Dom. Fam.)	48	3	48	3	30	3	37	3	100	0	69	0
Community Similarity	--	6	66%	3	52%	3	51%	3	10%	0	29%	0
Total Metric Score	39		21		21		24		3		9	
% Comparability To Reference Station			54%		54%		62%		8%		23%	
Biological Condition – Degree Impairment	Reference Station		Moderately impaired		Moderately impaired		Moderately impaired		Severely impaired		Moderately/severely impaired	

From reconnaissance (24 June 1997) we had determined that the aquatic habitat in a reach just downstream from First Avenue, Peabody could probably serve as a reference for the North River sampling site. The water depth and flow velocity appeared to be adequate and the rocky bottom substrates would have been ideal. When we arrived to sample on 29 July 1997, however, we found the portion upstream from the road looking more like a hypereutrophic lake—dense growths of rooted aquatic vegetation, attached filaments and floating mats of algae, and soft bottom sediments—than a brook. Downstream from the road, where we had intended to sample, the streambed was completely dry, presumably because of blockage under the bridge.

The only sample collected in this system, then, was in the North River downstream from Howley Street in a heavily industrialized section of Peabody. The habitat there was relatively poor (score: 95) but adequate to collect samples. Nonpoint source pollution from runoff, trash, and the bordering industrial uses (historical and current) are potentially serious impacts to the aquatic community at this site.

In spite of any limitations inherent in the reference sites selected, and even taking into account the poor rating of the habitat, this site was clearly degraded (Table C3 and Table C4). Though abundant in the sample the only family represented in the RBP subsample was the amphipod crustacean Gammaridae (Table C2). After extended picking through the sample only six non-amphipod invertebrates were found including: 1-Pisidiidae (fingernail clams); 2-Chironomidae (midges), and 3-Oligochaeta (aquatic earthworms). This river deserves further attention.

Hawkes Brook upstream from Hawkes Pond (HB02), Lynnfield; and from Hawkes Pond downstream to Saugus River, Saugus, MA

During reconnaissance conducted on 25 June 1997 the first 100 m or so of Hawkes Brook upstream from Salem Street, Lynnfield was a narrow, shallow stream with adequate velocity to create riffle habitats. Continuing upstream the brook skirted the yard of Don Mills. Mr. Mills showed us where a fence at the base of an embankment of a Route 128 ramp (MassHighways?) was installed such that it crossed the brook in two places. He said that during high runoff events large branches and debris collect on the fence (still evident at the time of our visit) impeding flow and causing the brook to flood his back yard and basement. It appeared that the problem could be remedied easily by moving a section of the fence a meter and thereby avoiding crossing the stream at all.

When we returned on 30 July 1997 to sample we discovered that Hawkes Brook through the Salem Street area was reduced to a thin trickle of water until it reached the inlet of Hawkes Pond. Following the brook down to Hawkes Pond, however, we discovered that the water height had dropped about 2 m and the pond area had shrunk since our June visit. The brook's channel was exposed flowing through what had been pond bottom a month earlier. In the vicinity of the pipeline crossing the riparian zone was the pond flood plain, and this was covered with purple loosestrife. The benthic invertebrate habitat in this reach was actually fairly good (score:124) with sufficiently coarse substrates and good current velocity (though the reach was fairly uniformly shallow riffle/run). This site was represented by 10 families (the best richness encountered in this watershed—Table C2) but it also had the highest biotic index (higher index values indicating greater impairment, often from organic enrichment). The RBP II ranking of this site was: moderately impaired (compared to FF01, Table C4). The poor performance of this site may well be due to its split lentic/lotic nature.

In spite of our efforts we could not find a suitable sampling site downstream from Hawkes Pond. There was too little water in the brook, even in June, with only a sluggish current. On 30 July 1997 we found the brook to be shallow and stagnant at Spring Street (Saugus). From Walnut Street downstream, through Camp Nihan, to the confluence with the Saugus River the water was shallow with little evidence of current. In fact, for most of this distance the bottom of the brook was heavily silted. The water in the channel was stagnant and putrid. According to the representation on the 1956 USGS topographic map the brook once flowed through the pond at the Camp. The brook was rerouted sometime prior to the 1971 USGS topographic map work to pass between the pond and what are now strip malls along Route 1 (perhaps to prevent contamination of the pond from these properties?).

Saugus River upstream from Lowell Street/Salem Street, Wakefield/Lynnfield (SR03), at Camp Nihan, Saugus (SR02B), and downstream from Elm Street, Saugus, MA (SR01)

The Saugus River drains wetlands in Reading and Wakefield without picking up much volume or velocity. The outlet of Quanapowit Lake also drains to the Saugus River in Wakefield, but at the time of our reconnaissance in June the flat, sandy-bottomed outlet channel had barely any water in it (just leakage from the outlet structure), i.e., most of the channel bottom was exposed. The first site we came to in the upper part of the river that appeared to have enough water and current velocity to allow us to conduct RBP sampling was at Lowell Street/Salem Street, Wakefield/Lynnfield (SR03). This reach was located downstream from a golf course and Route 128, which it passes under. In addition, the reach was bordered by residential/commercial properties (with maintained lawns) on the west bank and a strip mall and associated pavement on the east bank. There was notable erosion on both banks.

Even this site was marginally suited for RBP benthos work (habitat score: 97). The stream was shallow but had sufficient depth, coarse substrate, and riffle area to allow application of the RBP. SR03 matched Frost Fish Brook for number of families (10) and family biotic index value (5.6) though the assemblages had notable differences (Table C2). In particular, SR03 was heavily dominated by the filter-feeding Hydropsychidae—probably an indication that the combined effects of an upstream impoundment at the golf course, runoff from the highway, and erosion within the sample reach contribute to a high particulate loading that these organisms can exploit as a food source. RBP II analysis ranked this site as non/moderately impaired (Table C4) when compared against FF01, moderately impaired when compared against SR01 (Table C3). Though there is evidence that this reach is vulnerable to nonpoint source pollution and has obvious erosion problems it is likely that habitat limitations (partially supporting when compared to FF01 and nonsupporting when compared to SR01) related to the low volume of water in the river at this point plays a large role in the RBP II outcome.

Most of the river downstream from this point is low-gradient, flowing sluggishly through wetlands. We were able to access a wadeable stretch of the river at Camp Nihan (SR02B) to make a qualitative collection of the resident macroinvertebrates (Table C1). This reach was more lentic than lotic, with soft bottom substrates and submerged aquatic vegetation providing the majority of productive invertebrate habitat. The wetland was densely covered with the invader, purple loosestrife.

The most downstream site sampled on the Saugus River was downstream from Elm Street in Saugus (SR01). Somewhat ironically, this site provided the best lotic macroinvertebrate and fish habitat (score: 186) of all the North Coastal Watershed sites. The river channel appeared to have an unaltered natural pattern and there was a wide vegetated zone on both banks providing a good buffer. The head of the reach, however, did pass within a few meters of a factory (Centerless Grinding/N.E. Screw Machine). The river had well developed riffles and runs and a variety of water depths. The dominance of cobble and boulder in the reach provided excellent substrate for macroinvertebrates.

The richness of macroinvertebrate families (Table C2) was as high at this site as at any of the North Coastal Watershed sites and the biotic index value was the lowest (lower values indicating better health). The RBP II comparison with FF01 produced a score in the grey area between nonimpaired and moderately impaired (Table C4). All things considered, my judgement is that these results are not indicative of any problems in this reach.

Table C4. Summary of RBP II data analysis for macroinvertebrate communities sampled in the North Coastal Watershed during July 1997. Seven biological metrics were calculated and scored (in italic) for taxa collected at each station. Scores were then totaled and compared to an upstream reference station (FF01 – Frost Fish Brook downstream from Hemlock Street, Danvers, MA). The percent comparability to the reference station yields a final impairment score for each study site.

Station #	SR01		SR03		FF01		CR01		NR01		HB02	
Stream	Frost Fish Brook Danvers, MA		Crane River Danvers, MA		North River Peabody, MA		Hawkes Brook Lynnfield, MA		Saugus River Saugus, MA		Saugus River Wakefield/Lynnfield, MA	
Habitat Score	138/200		145/138 comparable		95/138 partially supporting		124/138 comparable		186/138 comparable		97/138 partially supporting	
Taxa Richness	10	6	6/10	3	1/10	0	10/10	6	10/10	6	10/10	6
Biotic Index	5.6	6	5.6/5.2	6	5.6/6.0	6	5.6/6.5	6	5.6/4.7	6	5.6/5.6	6
Ept Index	1	6	1/1	6	0	0	1/1	6	2/1	6	1/1	6
Ept/Chironomidae	0.5	6	10/0.5	6	0	0	0.57/0.5	6	2.4/0.5	6	16/0.5	6
Rifle Community: Scrapers/Filt. Coll.	1.1	6	0.67/1.1	6	0	0	0	0	0.21/1.1	0	0	0
% Contribution (Dom. Fam.)	30	3	37	3	100	0	69	0	48	3	48	3
Community Similarity	--	6	51%	3	14%	0	30%	3	52%	3	36%	3
Total Metric Score	--	39	33		6		27		30		30	
% Comparability To Reference Station			85%		15%		69%		77%		77%	
Biological Condition – Degree Impairment	Reference		Nonimpaired		Severely impaired		Moderately impaired		Non/Moderately impaired		Non/Moderately impaired	

CONCLUSIONS

In general our examination of selected sites within the North Coastal Watershed led to the conclusion that freshwater benthic macroinvertebrate communities are limited most by habitat. In some cases the predominant habitat features were natural and characteristic of the region (low gradient, low discharge), in others they no doubt reflected the impacts of development (channelization, elimination or reduction of buffer zones).

1. The one exception to the general conclusions was the **North River** in Peabody (NR01). Even considering its poor habitat—suffering from the effects of urbanization—this stream shows symptoms of a toxic impact. The assemblage of macroinvertebrates was, for all practical purposes, limited to a single taxon, Gammaridae. It is not unusual for polluted sites to exhibit hyperdominance by one or two particularly tolerant groups, but usually there are a variety of tolerant taxa also present in lower densities. In this case, extended picking through the sample failed to turn up more than a half dozen individuals that were not gammarids. A passerby who watched us sample suggested that an upstream tannery (or two?) may have poisoned the river. There may be merit to that assertion based on our findings. That conclusion, however, is based on the belief that the sample reach (immediately downstream from Howley Street) is above any tidal influence that might occasionally bring brackish waters into this reach. If this assumption is not correct it may account for the results obtained. If the assumption is correct, sediment analysis and/or sediment toxicity tests and/or instream toxicity tests may be appropriate to better define the problem here and identify possible remedies.
2. Though not detectable from the biomonitoring results, sites in the **Crane River** (CR01), **Waters River** (Sylvan Street, Peabody), **Goldthwaite Brook**, **Hawkes Brook** (at Camp Nihan just upstream from confluence with the Saugus River), and **Saugus River** (SR03), showed evidence of vulnerability to nonpoint source pollution contamination. The symptoms were erosion scars on stream banks, heavy deposits of silt and FPOM coating bottom substrates, heavy deposits of silt and sand at or downstream from stormwater pipes or runoff points, and accumulations of trash on stream banks and in the stream channels.
3. Impediments to flow should probably be addressed in **Hawkes Brook** upstream from Salem Street, Lynnfield, and **Goldthwaite Brook** at First Avenue, Peabody. Moving the fence along the Route 128 ramp so that it does not cross Hawkes Brook will prevent unnecessary flooding of properties along the brook. Removing any blockage that may exist under the First Avenue bridge similarly may help avoid unnecessary flooding and restore the lotic nature of the brook in this vicinity. It is unknown to what extent these actions will actually improve habitat for aquatic life, but they surely won't hurt.

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ATTACHMENT A

Glossary of Commonly Used Biomonitoring Terms, Abbreviations, and Acronyms

aquatic macroinvertebrates—broadly defined as freshwater (aquatic) animals large enough to be seen by the naked eye (macro) and lacking a backbone (invertebrate). The technical specification for this category is invertebrates retained on a U.S. Standard No. 30 sieve (590 µm opening). aquatic).

benthic invertebrates—those invertebrate organisms in or on the bottom or other substrates of surface waters. This term is often used interchangeably with aquatic macroinvertebrate in this report and other documents. As used in this report either term refers to those macroinvertebrates that are both aquatic and benthic. For practical purposes our application of aquatic macroinvertebrate assessments considers only aquatic members of the Mollusca (clams, mussels, snails), Annelida (worms), and Arthropoda (arachnids, crustaceans, and insects) because of considerations of both taxonomy and availability of information on environmental tolerances. Only life stages of the Insecta that are obligated to an aquatic existence are used in the analysis—typically the larval and pupal stages. All true bugs (Hemiptera), all Collembola (spring tails), and all adult Insecta, except the family Elmidae (riffle beetles), are excluded from the analysis because they use atmospheric air (instead of dissolved oxygen) for breathing and/or are capable of leaving the aquatic environment for dispersal or feeding (i.e., they are not truly benthic or aquatic).

benthos—the community of benthic macroinvertebrates.

EPT—An index calculated by adding up the number of different taxa present from each of the orders Ephemeroptera, Plecoptera, and Trichoptera. The members of these orders typically are intolerant of pollution.

functional feeding group—a classification of an organism's feeding habits. Scrapers typically feed by scraping microbes of hard substrates, filtering collectors spin nets or use morphological adaptations to collect particulates carried in the water, gathering collectors forage among deposited organic matter, shredders feed on live or dead plant materials (reducing from coarse to fine particulate organic matter), and predators engulf animals.

HBI—the Hilsenhoff biotic index (HBI). This index requires assignment of a pollution tolerance value for each taxon. The index is then calculated by the equation:

$$\sum \frac{v * c}{n}$$

where v = the pollution tolerance value assigned to an organism in a subsample; c = the count of the organism occurring in the subsample; and n = the total number of organisms making up the subsample.

RBP—rapid bioassessment protocols. The protocols typically employ a kick-sampling method (less often rock baskets or multiplates) of collecting benthos, field assessment of habitat quality (to produce a habitat score), sorting to obtain a subsample of 100 organisms, calculation of indicator metrics and scores relative to a reference site. The result is categorization of the site as nonimpaired, moderately impaired, or severely impaired if taxonomy was performed to the family level (RBP II); or as nonimpaired, slightly impaired, moderately impaired, or severely impaired if taxonomy was performed to the genus/species level (RBP III).

riffle—areas of a stream where bottom substrates are coarse enough and current velocity is fast enough to cause turbulent flow. These areas are evident from the broken appearance of the water surface and standing waves.

richness—the number of different taxa present.

tolerance value—a pollution score assigned to each taxon based on what is known about its pollution ecology. The values range from 0 for organisms very sensitive to organic enrichment/dissolved oxygen depletion to 10 for organisms that are extremely tolerant. The values are used to calculate an index value based on Hilsenhoff's biotic index (see HBI above).

taxa and taxonomy—taxa (singular: taxon) refers to the identity of organisms at any given level of classification. Taxonomy is the discipline of determining the proper placement (identification) of an organism into a particular level of classification (e.g., family or genus).

ATTACHMENT B

Common Names and Classification of Collected Benthic Macroinvertebrates

Mollusca (mollusks)

Gastropoda (snails)

Hydrobiidae

Physidae (pouch snails)

Pelecypoda (clams and mussels)

Unionidae (freshwater mussels)

Pisidiidae (fingernail clams)

Annelida (segmented worms)

Oligochaeta (aquatic earthworms)

Lumbricina

Tubificida

Enchytraeidae

Naididae

Tubificidae

Lumbriculida

Lumbriculidae

Hirudinea (leeches)

Rhyncobdellida

Glossiphoniidae

Arthropoda (jointed-legged animals)

Crustacea (crustaceans)

Isopoda (sow bugs)

Asellidae

Amphipoda (side-swimmers, brine shrimp)

Gammaridae

Insecta (insects)

Odonata (dragonflies and damselflies)

Aeshnidae

Megaloptera

Corydalidae (dobsonflies)

Trichoptera (caddisflies)

Philopotamidae

Polycentropodidae

Hydropsychidae

Glossosomatidae

Coleoptera (beetles)

Dytiscidae (predacious diving beetles)

Psephenidae (water pennies)

Elmidae (riffle beetles)

Diptera (flies)

Tipulidae (crane flies)

Simuliidae (black flies)

Chironomidae (midges)

Empididae (dance flies)

APPENDIX D - SEWAGE POLLUTION PROBLEMS CITY OF SALEM

Sewage Pollution Problems Corrected by the City of Salem DPW 1994 - 1998

<u>Location</u>	<u>Repair</u>	<u>Volume*</u>
Ward St. – Outfall at S. River, South Side	Removed 20 ± units	3,000 gpd
Harbor St. – Outfall at S. River, South Side	Removed 1 bar + 6 units	1,000 gpd
Peabody St. – Outfall at S. River, South Side	Removed 8 units	1,200 gpd
Congress St. – Outfall at S. River, North Side	Re-laid Sewer Networks	500 gpd
Pingree St. – Outfall at Palmer Cove, Shetland	Re-laid Sewer	100 gpd
Curtis St. – Outfall at NEPCO cooling canal	Removed 10 units	1,500 gpd
Orange St. - Outfall at NEPCO cooling canal	Removed 15 units	2,300 gpd
Essex St. - Outfall at NEPCO cooling canal	Removed 4 units	600 gpd
Derby St. – Outfall at Derby Wharf (site 630)	Removed 20 units	3,000 gpd
Herbert St. – Outfall at Derby Wharf (630)	Removed 20 units	3,000 gpd
Chestnut St. – Outfall to S. River via Gedney St.	Repaired sewer	15,000gpd
Hathorne Crescent – Outfall to S. River via Police Station Siphon	Repaired sewer	800 gpd
Beckford St. – Outfall to N. River by Burnham's	Repaired sewer	5,000 gpd
Boston St. – " "at bend in canal closest to Boston St.(upstream of site 501)	Repaired sewer	7,000 gpd
Beacon St. – Outfall at Conners Rd. (525)	Removed 2 units	500 gpd
Abbott St. – Outfall to N. River upstream of Howley St. (upstream of site 500)	Removed 6 units	1,980 gpd
Summit Ave. – Outfall to Glendale Cove at Willow Ave. (642)	Removed 1 unit	330 gpd
Connors Rd. – Outfall to Collins Cove(site 525)	Removed 2 units	500 gpd
Leach St. – Outfall to Glendale Cove (site 632)	Removed 1 unit	250 gpd
Boston St. and Goodhue St., Grove St. Bridge (536)	Removed connections	3,500 gpd
Total	Numerous sewer repairs and removed >115 units + 1 bar	51,060 gpd

* - Volume based on an assumption of 110 gpd per bedroom in a unit (house) and 2-3 bedrooms unless the house size is known.

Areas of On-going Investigation and Repair

- North River
- Palmer Cove
- South River
- Salem Harbor
- Glendale Cove
- Collins Cove

APPENDIX E - DEP 1999 GRANT AND LOAN PROGRAMS

Excerpted from the DEP/DWM World Wide Web site,
<http://www.state.ma.us/dep/brp/wm/wmpubs.htm#other> '1999 Grant and Loan Programs - Opportunities for Watershed Planning and Implementation'.

604(b) WATER QUALITY MANAGEMENT PLANNING GRANT PROGRAM

This grant program is authorized under the federal Clean Water Act Section 604(b) for water quality assessment and management planning.

104(b)(3) WETLANDS AND WATER QUALITY GRANT PROGRAM

This Grant Program is authorized under Wetlands and Clean Water Act Section 104(b)(3) of the federal Clean Water Act. The Water Quality proposals received by DEP under this National Environmental Performance Partnership Agreement (NEPPA) with the U.S. Environmental Protection Agency is a results oriented approach that will focus attention on environmental protection goals and the efforts to achieve them. The goals of the NEPPA are to: 1) achieve clean air, 2) achieve clean water, 3) protect wetlands, 4) reduce waste generation, and 5) clean up waste sites.

319 NONPOINT SOURCE GRANT PROGRAM

This grant program is authorized under Section 319 of the CWA for implementation projects that address the prevention, control, and abatement of nonpoint source (NPS) pollution. In order to be considered eligible for funding projects must: implement measures that address the prevention, control, and abatement of NPS pollution; target the major source(s) of nonpoint source pollution within a watershed/subwatershed; have a 40 percent non-federal match of the total project cost (match funds must meet the same eligibility criteria as the federal funds); contain an appropriate method for evaluating the project results; address activities that are identified in the Massachusetts NPS Management Program Plan.

RESEARCH AND DEMONSTRATION GRANT PROGRAM

The Research and Demonstration Program (R&D) is authorized by section 38 of Chapter 21 of the Massachusetts General Laws and is funded by proceeds from the sale of Massachusetts bonds. Specifically, the R&D Program was established to enable the Department to conduct a program of study and research and demonstration relating to water pollution control and other scientific and engineering studies "...so as to insure cleaner waters in the coastal waters, rivers, streams, lakes and ponds of the Commonwealth."

SOURCE WATER AND TECHNICAL ASSISTANCE/LAND MANAGEMENT GRANT PROGRAM

The Source Water Protection Technical Assistance/Land Management Grant Program provides funds to *third party* technical assistance organizations that assist public water suppliers in protecting local and regional ground and surface drinking water supplies.

WELLHEAD PROTECTION GRANT PROGRAM

The Wellhead Protection Grant Program provides funds to assist public water suppliers in addressing wellhead protection through local projects and education.

CLEAN WATER STATE REVOLVING LOAN FUND (SRF) PROGRAM

The Massachusetts State Revolving Fund for water pollution abatement projects was established to provide a low-cost funding mechanism to assist municipalities seeking to comply with federal and state water quality requirements. The SRF Program is jointly administered by the Division of Municipal Services of the Department of Environmental Protection and the Massachusetts Water Pollution Abatement Trust. Each year the Department solicits projects from Massachusetts municipalities and wastewater districts to be considered for subsidized loans, which are currently offered at 50% grant equivalency (approximates a no-interest loan). In recent years the program has operated at an annual capacity of \$150 to \$200 million per year, representing the financing of 40 to 50 projects annually. The SRF Program now provides increased emphasis on watershed management priorities. A major goal of the SRF Program is to provide incentives to communities to undertake projects with meaningful water quality and public health benefits and which address the needs of the communities and the watershed.

COMMUNITY SEPTIC MANAGEMENT PROGRAM

The enactment of the Open Space Bond Bill in March of 1996 provided new opportunities and stimulated new initiatives to assist homeowners with failing septic systems. The law appropriated \$30 million to the DEP to assist homeowners. The Department will use the appropriation to fund loans through the Massachusetts Water Pollution Abatement Trust. The fund will provide a permanent state/local administered revolving fund to assist income-eligible homeowners in financing necessary Title 5 repairs. Working together, the DEP and the Trust have created the Community Septic Management Program to help Massachusetts' communities protect threatened ground and surface waters while making it easier to comply with Title 5. This loan program offers three options from which a local governmental unit can choose.

MASSACHUSETTS DRINKING WATER STATE REVOLVING FUND PROGRAM

The Massachusetts Drinking Water State Revolving Fund (DWSRF) provides low-cost financing to help community public water suppliers comply with federal and state drinking water requirements. The DWSRF Program's goals are to protect public health and strengthen compliance with drinking water requirements, while addressing the Commonwealth's drinking water needs. The Program incorporates affordability and watershed management priorities. The DWSRF Program is jointly administered by the Division of Municipal Services of the Department of Environmental Protection (DEP) and the Massachusetts Water Pollution Abatement Trust (Trust). This month, DEP will solicit projects from Massachusetts municipalities and community water systems (with at least 15 residential connections) to be considered for subsidized loans. The current subsidy level is equivalent to a 50% grant, which approximates a *no-interest loan*. The Program will initially operate with approximately \$50 million in financing capacity. For calendar years 1998 through 2003, up to \$400 million may be available through the loan program.

APPENDIX F - DMF SHELLFISH DATA, NORTH COASTAL WATERSHED

It is the mission of the Division of Marine Fisheries (DMF) to manage, develop, and protect the Commonwealth's renewable living marine resources to provide the greatest public benefit. DMF fosters protection of the marine environment by cooperating with other state and federal agencies on pollution abatement, coastal wetlands protection and other programs concerning coastal waters and marine life. DMF monitors coastal contaminant levels in fish and shellfish, operates a shellfish depuration facility, and evaluates the impacts of coastal development on marine fish and their habitats. DMF provides assistance to local shellfish officers on matters affecting the management of shellfish, and provides expertise on anadromous fish and construction assistance on fishways. Other DMF programs assist commercial and recreational fishermen and educate the public on marine resource issues and values.

The DMF Shellfish Management Program manages shellfish growing areas in compliance with the National Shellfish Sanitation Program (NSSP). The NSSP is a federal/state cooperative program recognized by the U.S. Food and Drug Administration (FDA) and the Interstate Shellfish Sanitation Conference (ISSC). One goal of this program is the sanitary control of shellfish harvested and sold for human consumption. Growing areas are managed with respect to shellfish harvest for direct human consumption, and comprise at least one or more classification areas. The classification areas are the management units, and range from being approved to prohibited (six different classification types in all) with respect to shellfish harvest (Tables F1 and F3).

Table F1. DMF Shellfish Management Program Managed Shellfish Growing Area Classifications.

Classification Type	Definition
Approved	Open for harvest of shellfish for direct human consumption.
Conditionally Approved	During the time the area is approved, it is open for harvest of shellfish for direct human consumption subject to local rules and state regulations.
Conditionally Restricted	During the time the area is restricted, it is only open for the harvest of shellfish with depuration subject to local rules and state regulations.
Restricted	Open for harvest of shellfish with depuration subject to local rules and state regulations for the relay of shellfish.
Management Closure	Closed for the harvest of shellfish. Not enough testing has been done in the area to determine whether it is fit for shellfish harvest or not.
Prohibited	Closed for the harvest of shellfish.

Classification area codes and town names identify each DMF shellfish area. The North Coastal Watershed 1997/1998 Water Quality Assessment Report describes each shellfishing area by its classification area code and the assessed region is defined in square miles within the DEP/DWM water body system segment. As of 1 January 1999 DMF classified a total of 132742.1 acres in the North Coastal Watershed (Table F2).

Table F2. Summary Shellfish Classification Area Information as of 1 January 1999.

Classification Type	Area (acres)
Approved	18777.44
Conditionally Approved	2575.16
Management Closure	45720.53
Prohibited	65668.92

Table F3. DMF - Shellfish Project Classification Area Information as of 1 January 1999.

Town	Classification Area Code	Classification Type	Area (acres)
Beverly	N16.0	Prohibited	4097.65
Beverly	N17.0	Prohibited	488.80
Beverly	N19.0	Prohibited	4.71
Danvers	N17.0	Prohibited	250.21
Essex	N7.0	Conditionally Approved	689.05
Essex	N7.2	Prohibited	72.65
Essex	N7.3	Prohibited	28.94
Essex	N7.4	Prohibited	35.85
Essex	N7.5	Conditionally Approved	141.67
Essex	N7.6	Conditionally Approved	189.12
Gloucester	N10.0	Approved	8395.46
Gloucester	N10.1	Prohibited	2.30
Gloucester	N10.2	Prohibited	4.50
Gloucester	N10.3	Prohibited	3.04
Gloucester	N10.4	Prohibited	32.34
Gloucester	N12.0	Approved	2665.43
Gloucester	N12.1	Prohibited	62.83
Gloucester	N13.0	Management Closure	7639.49
Gloucester	N13.1	Prohibited	11.86
Gloucester	N14.0	Management Closure	6019.62
Gloucester	N7.0	Conditionally Approved	201.67
Gloucester	N7.1	Prohibited	4.93
Gloucester	N7.6	Conditionally Approved	205.03
Gloucester	N8.0	Approved	2117.53
Gloucester	N9.0	Prohibited	1472.44
Gloucester	N9.1	Prohibited	66.02
Gloucester	N9.10	Conditionally Approved	50.25
Gloucester	N9.11	Conditionally Approved	48.09
Gloucester	N9.12	Conditionally Approved	97.86
Gloucester	N9.13	Prohibited	18.88
Gloucester	N9.14	Prohibited	57.72
Gloucester	N9.15	Prohibited	17.20
Gloucester	N9.16	Conditionally Approved	8.32
Gloucester	N9.17	Prohibited	6.89
Gloucester	N9.18	Prohibited	13.96
Gloucester	N9.3	Conditionally Approved	54.32
Gloucester	N9.5	Conditionally Approved	9.71
Gloucester	N9.6	Conditionally Approved	36.36
Gloucester	N9.7	Conditionally Approved	370.37
Gloucester	N9.8	Prohibited	96.95
Gloucester	N9.9	Conditionally Approved	25.99
Ipswich	N10.0	Approved	271.72
Ipswich	N5.1	Prohibited	50.98
Ipswich	N6.0	Approved	4751.27
Ipswich	N6.1	Prohibited	119.25
Ipswich	N7.4	Prohibited	35.95
Ipswich	N7.5	Conditionally Approved	88.46
Ipswich	N7.6	Conditionally Approved	358.89

Table F3. (Continued) DMF - Shellfish Project Classification Area Information as of 1 January 1999.

Town	Classification Area Code	Classification Type	Area (acres)
Ipswich	N8.0	Approved	576.03
Lynn	N23.0	Prohibited	3394.45
Lynn	N24.0	Prohibited	0.02
Lynn	N26.0	Prohibited	435.08
Manchester	N15.0	Prohibited	11354.49
Manchester	N15.1	Prohibited	212.82
Manchester	N16.0	Prohibited	2.62
Marblehead	N18.0	Prohibited	329.63
Marblehead	N18.1	Prohibited	41.13
Marblehead	N19.0	Prohibited	2317.50
Marblehead	N20.0	Prohibited	476.62
Marblehead	N20.1	Prohibited	12.77
Marblehead	N21.0	Prohibited	10940.68
Marblehead	N21.1	Prohibited	44.74
Nahant	N24.0	Prohibited	3001.28
Nahant	N25.0	Prohibited	6626.88
Nahant	N26.0	Prohibited	1698.24
Peabody	N17.0	Prohibited	18.35
Revere	N26.0	Prohibited	2546.39
Revere	N26.1	Prohibited	71.33
Revere	N26.3	Prohibited	42.55
Revere	N26.4	Prohibited	56.74
Revere	N26.5	Prohibited	29.61
Revere	N26.6	Prohibited	57.83
Rockport	N11.0	Management Closure	28332.37
Rockport	N11.1	Prohibited	43.10
Salem	N17.0	Prohibited	590.45
Salem	N18.0	Prohibited	140.28
Salem	N18.1	Prohibited	424.09
Salem	N19.0	Prohibited	5993.87
Saugus	N26.0	Prohibited	163.71
Saugus	N26.3	Prohibited	43.09
Saugus	N26.4	Prohibited	1.06
Saugus	N26.6	Prohibited	27.57
Swampscott	N21.0	Prohibited	32.78
Swampscott	N22.0	Prohibited	6098.40
Swampscott	N22.1	Prohibited	33.01
Swampscott	N23.0	Prohibited	0.02
Territorial Waters	N11.0	Management Closure	3729.05
Winthrop	N25.0	Prohibited	713.90
Winthrop	N26.0	Prohibited	494.88
Winthrop	N26.2	Prohibited	100.11

